Submerged Steel Water Main at Minneapolis, Minn.

A 48-in. riveted steel water main is to be laid in a channel beneath the Mississippi River at Minneapolis, Minn., to increase the water-supply of South Minneapolis. The crossing will be at a point 1,000 ft. below the lower tailrace of St. Anthony's Falls. At this point the river banks are precipitate and rocky, the current of the river is swift and the bed of the river is composed of broken limestone to a depth of 40 ft. or more. The pipe will be laid with its top 5 ft. below the present water surface. An attempt will be made to dig the trench by means of a clamshell bucket, supported on a cribbing of steel I-beams. The pipe will be laid in sections 30 ft. long, supported and lowered as each section is added. The crossing is 1,500 ft. in length, and it will terminate at each end in vertical shafts. There are already four water mains across the Mississippi at Minneapolis. One of these is 16 in. in diameter, two are 24 in., and one is 50 in. The new 48-in. steel crossing will connect with 6 mi. of 48-in. pipe laid during the last season between the river and a reservoir. The first $1\frac{7}{4}$ mi. of main from the reservoir is of cast-iron pipe, and the remaining $4\frac{1}{2}$ mi. is of lock-bar steel pipe. J. A. Jensen is supervisor of water-works at Minneapolis, and F. W. Cappelen is city engineer.

Mayor Curley Condemned by Boston Engineers

Seven leading Boston civil engineers have spoken in no uncertain terms of Mayor Curley's recent decapitation of 17 employees, mostly engineers, in the Public Works Department of that city (see *Engineering News*, Jan. 27, 1916, pages 184 and 193). The engineers who united in a strong protest against this action were Frederic P. Stearns, Desmond FitzGerald, Henry F. Bryant, Charles T. Main, Harrison P. Eddy, Frank A. Barbour and Edward C. Sherman. These engineers express the opinion that in the action mentioned Mayor Curley "struck a disastrous blow, which not only affects most seriously the present efficiency of the department, but will, unless it is counteracted, lower the standard of efficiency to a still greater extent in the future." The seven engineers point out that most of the men discharged on 48-hr. notice were civil engineers, a number of whom held responsible positions and that:

> It is apparent that when 17 experienced, efficient men holding such positions are simultaneously removed, the fact offers a strong presumption that the removal must have been made without just cause and contrary to the spirit and intent of the state law for protecting persons included in the classified civil service.

After pointing out that in their opinion the alleged abolition of the offices held by these 17 men was only a "subterfuge, because the work performed by these men must continue," the statement issued by the seven engineers continues:

> We believe that these removals are contrary to the spirit and intent of the law and should meet with a most earnest protest from every citizen of Boston and from all who believe in the maintenance of an official civil service.
>
> We especially commend the action of three of the men in contesting the action of the mayor, and we believe that they deserve the active support of all public-spirited citizens who are interested in securing the best possible results for the city in the matter of good sewers, streets and adequate fire protection and the other phases of the work of the Public Works Department which are so essential to the health and well-being of every citizen of Boston.
>
> Every citizen should realize that at the perfunctory hearing given four of these men by the Commissioner of Public Works he was obliged to admit that there was no question as to their efficiency.

The statement next refers to the custom prevalent in Boston of promoting civil engineers from the lower to the higher grades of the city service and continues:

> This practice has brought to the service of the city and retained in it for many years engineers who were both trustworthy and qualified for their work, but the recent action of Mayor Curley in removing without just cause men who have given loyal service for a long term of years meant not only that competent engineers will refuse to enter the service of the city in the future, but that those still in the service will be anxious to leave as soon as opportunity offers for other employment.

To show that the seven engineers who are making this protest held no special brief for members of the engineering profession, the seven engineers say that "the principles involved are equally applicable to trained men in charge of other branches of the service."

That an able and successful politician like Mayor Curley would strike back was to be expected; but it is surprising to find not only how weak his attempted self-justification is, but also that, whereas in announcement and utterances at the time the decapitation took place he spoke boldly about the action as being his own, in his reply he seems to try to shift the responsibility and to make out that it was really a case of one engineer sitting in judgment upon others in the interest of efficiency. Thus he says:

> The Commissioner of Public Works discharged those whose services he deemed unnecessary. He is an engineer himself and presumably knows how many engineers his department requires as well as which engineers may best be dispensed with. In other words, he has both knowledge of the situation and responsibility combined.

Mistaking the action of the seven engineers for that of the Boston Society of Engineers, the Mayor continues:

> The action of the Society of Engineers, therefore, reduced to its simplest terms, is a protest of a body unfamiliar with the premises, and without responsibility, against the action of a competent engineer. . . . The Engineers' Society, like other societies we have in Boston, is an ardent advocate of economy, but when the economy strikes members of their own profession they raise a howl that can be heard across the continent.
>
> What they desire is economy at the expense of the other fellow. When one of their societies discharged day laborers in the City of Boston by the hundred the Boston Society of Engineers was singularly silent.

The mayor's reply contained more of much the same sort, but enough has been quoted from it to show his line of reasoning and the vigor and picturesqueness of his language—also to make it obvious that he mistakes the spirit of the protest.

Rogers Pass Tunnel Progress

The progress record of the Rogers Pass tunnel on the Canadian Pacific Ry., from July to December, is given herewith. This supplements the previous record and the note on the holing through of this great tunnel, in *Engineering News*, Nov. 11, 1915, and Jan. 6, 1916.

	July 29 to Sept. 2 Ft.	Sept. 2 to Sept. 30 Ft.	Sept. 30 to Oct. 28 Ft.	Oct. 20 to Dec. 2 Ft.	Total, Dec. 2 Ft.
East End:					
Pioneer heading	(Complete)	.....	.....	.....	10,740
Main heading	1,455	1,381	1,049	1,429	11,858
Main tunnel	690	672	669	806	8,053
West End:					
Pioneer heading	(Complete)	.....	.....	.....	8,870
Main heading	1,400	1,151	1,109	783	11,912
Main tunnel	951	706	699	840	6,950

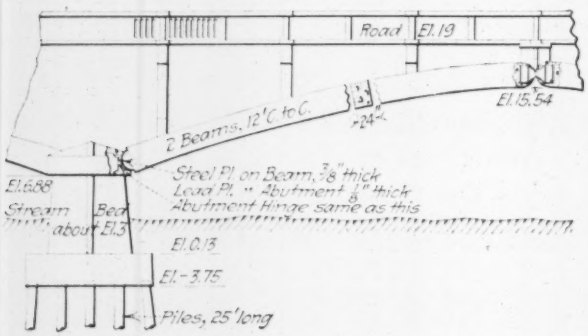
Minneapolis To Spend a Million on Day-Labor Paving

Continuing its plan of pavement construction by day labor, the City of Minneapolis proposes to lay about 400,000 sq.yd. of pavements in 1916, at an estimated cost of $1,060,000. Except for a comparatively small amount of brick, all the new pavement will be of 3½- and 4-in. creosoted Southern long-leaf pine blocks laid on concrete. With the first favorable weather Ellis R. Dutton, assistant city engineer in charge of paving, expects to put 12 paving crews to work. Double the equipment now owned by the city will be purchased.

The highest amount of paving work done previously was $650,000 worth in 1913. Owing to unavoidable delays, the total of the 1915 paving operations was only $450,000. Other day-labor municipal projects in Minneapolis will bring the total for municipal construction under this plan in 1916 above $3,000,000.

Three-Hinged Concrete Bridge Fails by Undermining

A three-hinged reinforced-concrete bridge of the Thomas type, across the San Diego River just north of San Diego, Calif., was destroyed by floods on Jan. 27. This type of bridge is the one in which half-arch ribs are cast on the ground and raised into place against spring



ONE PIER AND ARCH OF THE OLD TOWN BRIDGE

and crown hinges, the superstructure then being cast in place on the ribs, with liberal use of precast members for struts, beams, etc.

The bridge in question is on the road from San Diego to Los Angeles, at Old Town. It was built in 1914 and was designed by Thomas & Post, of Los Angeles. The details of one of the spans are shown in the accompanying sketch, forwarded by John L. Bacon, of San Diego, an engineer who was on the bridge observing its progressive failure up to a few minutes before its collapse.

The bridge had three 100-ft. spans and was a three-hinged arch structure with piers resting on piles about 25 ft. long. The river bed is of sand and silt extending to a great depth and is entirely dry during the summer months. The elevation of the stream bed before the flood was about 3 ft. above tidewater, and the piles were cut off about 4 ft. below. The soffit of the arches at the crown was at 15.54 ft. elevation.

The San Diego River flows from mountains 30 to 50 mi. back from the coast, rising to elevations of 1,000 to 6,000 ft. These conditions produce a heavy rainfall at the headwaters and rapid runoff. It is probable that the volume and force of the flood were so great as to scour the river channel at the bridge to great depth and undermine the piles.

Apparently one of the two river piers was first undermined by the rushing water and commenced to sink, the first indication being the gradual lowering of the roadway at the crown of the middle arch opening. The expansion joint in the roadway over the other river pier then began to open; about an hour later the joints in the concrete top rail began to spall under compression, and a half-hour later the central arch dropped, immediately followed by the two adjoining arches and the two river piers.

Ohio, Mississippi, Arkansas and White River Floods

Cumulative effects of rainfall from time to time since the middle of December, 1915, have caused both the Ohio and Mississippi Rivers to be in flood at their junction at Cairo, Ill., with the likelihood that the Arkansas, White and Mississippi will also be in flood at one time at the junction of these three rivers. E. M. Markham, Major, Corps of Engineers, U. S. A., Memphis, Tenn., in reviewing for *Engineering News* elsewhere in this issue the flood conditions in the lower Mississippi as far south as the mouth of the White River, states that on Feb. 5 there were indications of a flood plane from Cairo to the White River that would be only a foot lower than that of 1913.

The character and effect of flood conditions on the Arkansas and White Rivers, including conditions at Little Rock, have been summarized for *Engineering News* by Elliott J. Dent, Major, Corps of Engineers, U. S. A., Little Rock, Ark., under date of Feb. 6, as follows:

The branches of the upper Arkansas River in Kansas and Oklahoma rose 6 to 14 ft. on Jan. 21, and 7 to 18 ft. on Jan. 21 and 22. On Jan. 27 to 31 rainfall was general on all the watersheds of the Little Rock district, with 5 in. of precipitation at Little Rock. In the Arkansas River the second flood caught the crest of the first flood. The river stage at Little Rock was 27.3 ft. on Feb. 3, compared with a maximum recorded stage of 29.1 ft. The White River at Batesville rose 29 ft. from Jan. 27 to Feb. 1, reaching a stage of 38.1 ft., against a maximum record of 37.5 ft. Newport was flooded Feb. 1, but is dry now (Feb. 6).

The Arkansas River below Moscow and the White River below Devall Bluff were affected by backwater from the Mississippi. The Helena gage showed a 48- to 52-ft. level. The levees on the south bank of the Arkansas River below Pine Bluff were overtopped or breached at several points. Water flowing south to Bayou Bartholomew flooded Grady, Varner, Gould and Dumas, causing much hardship through exposure and the loss of many head of stock. Trouble is now (Feb. 6) feared from McGehee to Arkansas City. The Clarendon levee broke Saturday night, Feb. 5, but a serious condition is not probable.

The White River locks were slightly damaged. About 1,500 ft. of revetment was lost at Pine Bluff (see "Engineering News," Jan. 14, 1909, p. 47), and many levees were breached.

The Cotton Belt R.R. line was flooded near Clarendon. The extent of the damage is unknown, but is believed to be slight. The Rock Island R.R. tracks are flooded in the vicinity of Newport, resulting in slight damage. There are some washouts in the White River bottom. The tracks of the Missouri River system between McGehee and the Arkansas River and between McGehee and Grady are flooded, but the extent of the damage has not yet been reported here. Water is rising over the tracks at Arkansas City.

The railway line from Little Rock to Memphis was blocked 12 hr., owing to a washout. The line from Little Rock to St. Louis was overflowed and washed out near Newport, and passengers on the marooned train were rescued by motor boat. The damage to the railroad line up the White River from Newport is as yet unknown. Two bridges were lost

near Gibson. The total damage to the Missouri Pacific is probably $200,000.

At St. Louis, Mo., 4.65 in. of rain fell from Jan. 27 to 31, distributed by days as follows: 0.55, 0.10, 0.75, 2.5, 1.20. The rain came on top of a thaw, and the ground was saturated. The River des Peres and the Meramec River were high, but not so high as they were last August. Train service on the Frisco and Missouri Pacific lines, which follow the Meramec Valley, was annulled from the morning of Jan. 30 to the evening of Feb. 1, but no serious damage was done to the railroads.

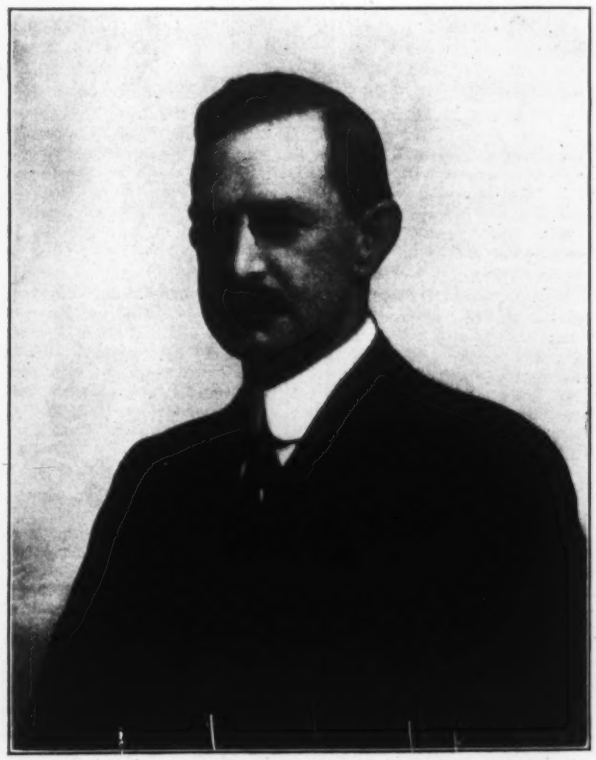
The Mississippi River rose to the extraordinary stage of 33 on the St. Louis gage, which was 3 ft. above the danger line. January high-water levels for the last 15 yr. have been: 1903, 11 ft.; 1904 and 1906, 15 ft.; 1907 and 1910, 10 ft.

The contractors on the Mill Creek sewer, St. Louis, had to meet a combination of high water in the Mississippi and heavy rainfall. To stop seepage of the river water into the eastern tunnel heading, part of the heading was bulkheaded off and flooded.

Erie Railroad Appoints New Chief Engineer

Robert Stevens Parsons, M. Am. Soc. C. E., since 1914 General Manager, at Cleveland, of the Ohio Grand Division of the Erie R.R., now known as the Erie Lines West, has been appointed Chief Engineer of the company, with headquarters at New York City. He was born at Hohokus, N. J., and is a graduate of Rutgers College, from which institution he received the degree of civil engineer in 1897.

In 1895 Mr. Parsons entered the service of the Erie as a rodman and the following year was made Assistant Engineer. Three years later he became Division Engineer of the New York, Susquehanna & Western R.R. In 1903 he was appointed Engineer of Maintenance-of-Way of the Erie and in 1906 became Assistant General Superintendent of the road. He was promoted to Superintendent of the Susquehanna Division in 1907 and in 1910 was transferred in the same capacity to the New York Division. On Jan. 1, 1913, Mr. Parsons was appointed Assistant General Manager of the Lines East of Buffalo and Salamanca, with headquarters at New York City, and a year later was appointed to the position of General Manager at Cleveland, which he has occupied until his present appointment.



ROBERT STEVENS PARSONS

A 150,000-Gal. Activated-Sludge Plant to treat packing-town sewage was put into operation the latter part of January by the Sanitary District of Chicago, under the direction of Langdon Pearse, division engineer, and Dr. Arthur J. Lederer, chemist.

Nearly 3,000,000 Cu.Yd. of Excavation in 11 weeks is the record of the dredges working on the Panama Canal slides. The total output in the 11 weeks ending Jan. 10 was 2,907,492 cu.yd. Besides this primary excavation, 264,317 cu.yd. of material was rehandled during that time by the dredges.

Federal Aid to State Road Construction is provided for in a bill that passed the House of Representatives on Jan. 25 by a vote of 281 to 81. The bill, which was introduced by Mr. Shackleford, of Missouri, carries an appropriation of $25,000,000 and is framed on similar lines to the Shackleford bill that passed the House in the last Congress, but failed in the Senate.

The Reported Partial Failure of the Sweetwater dam, near San Diego, in the flood of Jan. 27, was really the failure of an earth dike about half a mile from the large concrete dam. A short extension of the concrete dam at the north end, consisting of an earth- and rock-fill with a concrete core wall, was also washed out. The level of the water in the reservoir was lowered about 20 ft. by these breaks, leaving a depth of about 78 ft.

A Rapid-Transit Investigation is expected to go forward in Chicago as soon as a board of engineers can be appointed for this purpose. It has been incorrectly reported that such a board has been appointed, or named, by a subcommittee of the council committee on local transportation. The facts of the case are that the subcommittee has recommended to the committee that the investigating board consist of the following engineers: Bion J. Arnold, of Chicago; William Barclay Parsons, of New York City; and Robert Ridgway, of the New York Public Service Commission. These names must be accepted by the council and approved by the mayor to make them official. The purpose of this investigation is to have the engineers report to the city upon a comprehensive and interrelated system of local transportation, including the existing surface and elevated lines and the proposed subways.

New York Subway Progress—On Feb. 2 the south tube in the Old Slip-Clark St. tunnel was "holed through" on the Manhattan side to the southern end of the William St. subway. The connection was made about 750 ft. west of the East River, at the junction of the two contracts—that for the tunnel under the river, held by the Flinn-O'Rourke Co., and that for the William St. subway, held by Smith, Hauser & MacIsaac. It is now possible to walk through the tunnel from the air lock 350 ft. from the river edge into the completed structure in William St. The easterly end of the tunnel is now out under the East River to a point about 150 ft. from the bulkhead line. This line is for operation by the Interborough Rapid Transit Co. It leaves the Seventh Ave. subway at Park Place and runs under Park Place, the United States Post Office, Beekman St. and William St. to a junction with the tunnel at Old Slip. From Old Slip the line passes under the East River to Clark St., Brooklyn, and up Clark and Willoughby St. to a connection with the existing subway near Borough Hall.

A Phenomenal Snowfall and Low Temperature prevailed over the North Pacific Coast all the way from Alaska to California during the month of January. In the lower altitudes of the coast section of Oregon and Washington, the fall of any quantity of snow is a rarity. Logging work in Eastern Canada and the northern United States is generally carried on entirely in the winter and is dependent upon a good snowfall. The Pacific coast production, however, is carried on by other methods entirely and the heavy snowfall of January reduced the lumber production of Oregon and Washington for the

month to one-fifth of the normal. In Seattle, Wash., the snow conditions were exceptionally severe, the average snow on the ground at one time being 30 in. In the drifts, which reached a depth of from 4 to 7 ft., the weight of snow varied from 10 lb. per cu.ft. on top to 20 lb. in the lower sections. The dome of St. James Cathedral, a steel structure of 40-ft. span, collapsed, due to the weight of snow on a lower roof framing into the columns that held the dome. One of these columns was the original place of failure.

Water-Power Legislation by the present Congress is anxiously awaited by those in charge of a number of very large water-power enterprises. House Bill No. 408, generally known as the Ferris bill and framed on lines similar to the Ferris bill which passed the House in the last Congress, passed the House on Jan. 8. This bill empowers the Secretary of the Interior to lease public lands of the United States for water-power development for periods of not more than 50 yr., such leases to be irrevocable except for breach of their terms. Control of corporations developing power under such leases is to lie with the public-service commisisons of the states where the plant is located; or if no such commission exists, with the Secretary of the Interior. At the expiration of the lease the United States may take over the property, paying therefor its reasonable value plus the expenditure on water rights, rights-of-way, etc., but not including payments for intangible elements. Rentals collected under the leases are to accrue to the reclamation fund. The Senate has also before it the Myers bill (No. 1060), framed on similar lines but differing in some details.

Frozen Concrete again appears to be the cause of a building collapse in the case of the wreck of the factory building at Rockford, Ill., on Nov. 19. The fall of the floors caused the death of two men, and the verdict of the coroner's jury has just been rendered. The building was for Shanhouse & Sons. The floor spans were 17x21 ft., with 7-in. slabs enlarged to 11 in. in thickness around the column heads and reinforced by the Barton spider-web system. The first floor had been poured about six weeks before, and since that time there had been some very cold weather. The second floor was poured on the day previous to the accident (Nov. 18), so that this concrete had had no time to set. Nov. 19 was a very wet day. At the time of the accident the forms and falsework under the first floor were being removed. The first indication of failure noticed (by a man beneath this floor) was a crack through one of the 11-in. column heads. Then the floor collapsed and the forms and fresh concrete of the upper floor fell with it, stripping clear of the steel reinforcement. The column heads of the first floor were sheared off. An investigation was made by C. C. Stowell, of Rockford, on behalf of the owners of the building, the contractor and the architect. Another investigation was made by Ernest McCullough, of Chicago, on behalf of the Barton Spider Web System Co. The former testified before the coroner's jury that there was considerable frost in the concrete slab and that the concrete was very porous, owing to the use of an excess of water in order to make the concrete flow readily around the reinforcing rods. The proportions were good, but in pouring the concrete the heavier gravel separated from the sand and grout. Samples tested at the laboratory of the University of Illinois showed insufficient strength. There were not sufficient supports to hold the slab rigidly during the period of setting. In Mr. Stowell's opinion the accident was due to premature removal of the falsework supporting the forms, the weather having retarded the setting of the concrete. Similar conclusions were given in a report by Mr. McCullough, who also recommended that the remaining parts of the floor should be torn down. The verdict of the jury (Dec. 29) was that the death of the two men was due to removal of the supports of the first floor before the concrete had properly set. It recommended also that the city pass a building ordinance and provide for a qualified building inspector to enforce its provisions.

PERSONALS

Mr. Charles S. Hervey, Deputy Comptroller of the City of New York, has been appointed Public Service Commissioner of the First District of the State of New York.

Mr. Julius Adler, formerly connected with the Philadelphia Highway Department, has been appointed Engineer of Tests of the Pennsylvania State Highway Department.

Mr. John T. Gephart, Jr., Engineer of Construction of the Pennsylvania State Highway Department, has resigned to become Consulting Engineer of Fayette County, Pennsylvania.

Mr. E. C. Waldvogel, who has been connected with the Yale & Towne Manufacturing Co., of New York, for the past 11 yr., has been appointed General Manager of the company.

Mr. Travis H. Whitney, present Secretary of the Public Service Commission for the First District of the State of New York, has been appointed Public Service Commissioner to succeed J. Sergeant Cram, whose term expired Feb. 1.

Prof. Harry H. Stoek, M. Am. Inst. M. E., head of the Department of Mining Engineering of the University of Illinois, has been appointed a member of the Illinois State Mining Investigation Commission, which is to consider legislation affecting the mining interests.

Mr. Charles E. Jenkins, M. Am. Soc. C. E., for 11 years the Engineer of Maintenance-of-Way of the Easton Transit Co., Easton, Penn., has been appointed Chief Engineer of the Lehigh Valley Transit Co. at Allentown, Penn., to succeed Mr. W. W. Wysor, who recently resigned.

Mr. F. A. Dunham announces the incorporation of the F. A. Dunham-Clarin Co., with offices at 109 Park Ave., Plainfield, N. J. The company will continue the civil-engineering and surveying business conducted for 42 years by Mr. Dunham. Mr. David X. Clarin has been head engineer for Mr. Dunham for the past five years.

Mr. Angus M. Hibbard, Fel. Am. Inst. E. E., for 18 years General Manager of the Chicago Telephone Co. and for 11 years with the American Telephone and Telegraph Co., Chicago, has opened an office as Consulting Engineer in the Bell Telephone Building in that city and will make a specialty of efficiency investigations and arbitration work.

Mr. John H. Lewis, Assoc. M. Am. Soc. C. E., State Engineer of Oregon, has been given complete supervision of the state roads and bridges. He has placed E. I. Cantine, M. Am. Soc. C. E., contractor, of Portland, in charge of road work and has abolished the state bridge engineer's office upon the resignation of H. W. Holmes, Assoc. M. Am. Soc. C. E., who will enter private practice.

Mr. Clarence W. Marsh has opened an office as consulting and chemical engineer at 201 Devonshire St., Boston, Mass. For the past 12 yr. he has served as Chief Engineer and Special Investigator, and as Director, of the Hooker Chemical Co. and the Development and Funding Co., of New York. Mr. Marsh has specialized in the manufacture of electrolytic caustic soda, bleach and chlorine products.

Mr. Fred Lavis, M. Am. Soc. C. E., Consulting Engineer, New York City, has become associated with the American International Corporation in an advisory capacity in regard to railway and general development projects in Central and South America. Mr. Lavis has had a wide experience on railway location and construction and for several years past has been engaged in making examinations of railway projects for financial institutions, both of this country and of Europe.

Messrs. H. K. Barrows, M. Am. Soc. C. E., and C. B. Breed, M. Am. Soc. C. E., announce the dissolution of the firm of Barrows & Breed, 6 Beacon St., Boston, Mass. Mr. Barrows and Mr. Breed will occupy joint offices at the same address. Mr. Barrows will continue his practice as a consulting hydraulic engineer, giving special attention to water power, water-supply and sewerage. Mr. Breed will continue his general practice as consulting engineer, specializing in railroad, structural and municipal projects.

Mr. Charles F. Schulz, Commissioner of Water, Cleveland, Ohio, will be retired on Mar. 1 in accordance with a plan of the new city administration to pass an ordinance combining the water and lighting departments of the city, with an alleged saving of Mr. Schulz' salary of $5,000 and clerk time. Mr. Schulz has been in the city service for 34 years and was for many years civil engineer of the water-works. For the present the water-works will be in charge of Charles P. Jaeger, Deputy Commissioner of Water.

Mr. John Miller, Assistant Engineer with J. C. Bland, Engineer of Bridges, Pennsylvania Lines West of Pittsburgh, at Pittsburgh, has resigned to accept a position in the Bridge Department of the Great Eastern Ry. of England, under H. W. Thornton, General Manager, formerly with the Long Island R.R. Mr. Miller, who is a graduate in engineering of the Royal University of Ireland, taught for some time in the Engineering Department of the City and Guilds of London College and has been for six years in the Bridge Department of the Pennsylvania company.

Maj. Horton W. Stickle, who in August of last year took charge of the United States Engineer Office at Baltimore, has retired from the army, becoming automatically a lieutenant-colonel. Major Stickle was transferred from Wilmington, N. C., to the Baltimore office, which embraces the greater part of Chesapeake Bay and its tributaries, soon after which he

asked to be retired under the law allowing engineer officers of the army who have served three years on the Panama Canal to do so at the advanced rating. It is stated that Colonel Stickle will connect himself with a New York contracting firm.

Mr. Edmund F. Saxton, recently Assistant Director of the Department of Wharves, Docks and Ferries of Philadelphia, has opened offices to conduct a general consulting engineering practice, in the Pennsylvania Building, Philadelphia. He will be associated with Mr. John Meigs, M. Am. Soc. C. E., formerly Director of the Department of Wharves, Docks and Ferries of Philadelphia. Special attention will be given to municipal problems, valuations, railways, ocean and river piers and wharves, design, testing, supervision and construction of general work. Projects in Latin-American countries will be solicited. Mr. Sexton was formerly Chief Engineer of the United Railways of Yucatan, including the port of Progreso.

OBITUARY

Oswald Jackson, civil engineer, died at his home in New York City, on Jan. 30, at 45 years of age. Mr. Jackson was a graduate of Columbia University, class of 1892.

George Way Swinburne, M. Am. Soc. C. E., associated with the Sterilization Co., of Newark, N. J., died at his home in East Orange, N. J., on Feb. 3. He was 57 years of age and was born in Newport, R. I.

Richard S. Bryant, Factory Manager of the Standard Welding Co., Cleveland, Ohio, died at the Post Graduate Hospital, New York City, on Jan. 31. Mr. Bryant was widely known as an authority on automobile rims. He was born in 1869.

Thomas J. Allen, engineer and railroad and bridge builder, died at his home in Netcong, N. J., on Feb. 4, in his sixty-fifth year. With his father and brother Mr. Allen built the coal docks of the Lackawanna R.R. at Port Morris, N. Y. He also constructed a number of bridges in South America, Mexico and this country.

ENGINEERING SOCIETIES

COMING MEETINGS

NINTH CHICAGO CEMENT SHOW.
Feb. 12-19. First Infantry Armory and Coliseum. Secy., R. F. Hall, 208 South La Salle St., Chicago, Ill.

CONNECTICUT SOCIETY OF CIVIL ENGINEERS.
Feb. 14-15. Annual meeting at New Haven. Secy., J. Frederick Jackson, Chamber of Commerce Bldg., New Haven, Conn.

BUILDING INSPECTORS' CONFERENCE.
Feb. 14-15. In Chicago. Secy., S. J. Williams, Madison, Wis.

AMERICAN CONCRETE INSTITUTE.
Feb. 14-17. Annual convention in Chicago. Secy., John M. Goodell, 1418 Walnut St., Philadelphia, Penn.

AMERICAN INSTITUTE OF MINING ENGINEERS.
Feb. 14-17. Annual meeting in New York City. Secy., Bradley Stoughton, 29 W. 39th St., New York City.

ASSOCIATION OF ONTARIO LAND SURVEYORS.
Feb. 15. Annual meeting in Toronto, Can. Secy., L. V. Rorke, Parliament Building, Toronto, Ont.

SECOND NATIONAL CONFERENCE ON CONCRETE ROAD BUILDING.
Feb. 15-18. At Chicago. Secy., J. P. Beck, 208 South La Salle St., Chicago, Ill.

IOWA ENGINEERING SOCIETY.
Feb. 16-18. Annual meeting at Des Moines. Secy., J. H. Dunlap, Iowa City, Iowa.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS.
Feb. 16. Annual meeting in Boston. Secy., N. W. Gifford, 38 Central Sq., East Boston, Mass.

AMERICAN CONCRETE PIPE ASSOCIATION.
Feb. 17-18. Annual convention in Chicago. Secy., E. S. Hanson, 538 South Clark St., Chicago, Ill.

IDAHO SOCIETY OF ENGINEERS.
Feb. 21-23. Annual meeting in Burley. Secy., I. F. Shaffner, Boise, Idaho.

ARKANSAS ENGINEERING SOCIETY.
Feb. 22-23. Annual meeting at Helena. Secy., W. J. Parkes, Citizens Bank Building, Pine Bluff, Ark.

AMERICAN ROAD BUILDERS' ASSOCIATION.
Feb. 28 to Mar. 3. Annual convention in Pittsburgh. Secy., E. L. Powers, 150 Nasau St., New York City.

ENGINEERING SOCIETY OF WISCONSIN.
Feb. 25-26. Annual meeting in Madison. Secy., L. S. Smith, Madison, Wis.

American Road Builders' Association—At the annual meeting, held on Feb. 4, the following officers were elected: President, Col. E. A. Stevens, Commissioner of Public Roads of New Jersey; first vice-president, Arthur W. Dean, Chief Engineer, Massachusetts Highway Commission; second vice-president, Austin B. Fletcher, State Highway Engineer of California; third vice-president, William H. Connell, Chief, Bureau of Highways and Street Cleaning, Philadelphia, Penn.; secretary, E. L. Powers, Editor of "Good Roads"; treasurer, W. W. Crosby, Consulting Engineer, Baltimore, Md.; directors for three years—R. Keith Compton, Charles W. Gates, James H. MacDonald, R. A. Meeker, William D. Uhler, Frank M. Williams. The office of the secretary is at 150 Nassau St., New York City. The executive committee of the association has issued a statement regarding the published claim that the association, in arranging for a meeting in Pittsburgh on Feb. 28, has violated an agreement made with the American Highway Association. The executive committee of the American Road Builders' Association claims that the promise made to the supporters of the joint congress held at Oakland, Calif., in September last, was that neither association would hold any other convention during the year 1915. The officers of the Road Builders' Association had for some time been planning to change the date of their annual meeting so that it will be held before the opening of the road-building season instead of after it and decided to make the change this year. The committee therefore believes that the association has not violated either the letter or the spirit of any agreement in scheduling its meeting for Feb. 28, 1916.

The New England Water-Works Association will meet on Feb. 9 in Boston, at the Hotel Brunswick, to discuss the "Causes of Explosions of Domestic Boilers" and the "Progress of Water Sterilization in Maryland."

The Nashville Section of the Engineering Association of the South now holds weekly lunch meetings, instead of the monthly meetings held previously. It is intended that subjects of general importance shall be discussed at the luncheons. John Howe Peyton is president of the section.

Mississippi Valley Terminal League—The second annual convention will be held at the Planters Hotel, St. Louis, Mo., Feb. 16. The purpose of the association is to stimulate cities and towns to provide suitable waterfront facilities for steamers and freight handling. Reports will be presented showing what various cities along the Mississippi River are doing in the way of providing such water terminals. C. F. Perry, Quincy, Ill., is secretary.

American Institute of Consulting Engineers—An error occurred in the report of the annual meeting, published on page 143 of the issue of Jan. 20. The result of the letter ballot announced at the meeting was the election of the following members of the institute's council: Dr. George F. Swain, Dr. Alexander C. Humphreys, Samuel Whinery and F. A. Molitor. The president and other officers of the institute will be elected by the council at its first meeting in February.

The Engineering Society of Wisconsin will hold its seventh annual meeting Feb. 25 to 26, at the Engineering Building of the University of Wisconsin. Among the papers to be presented are: "The Relation of Engineers and Contractors"; "Some Phases of the Wisconsin Building Code Work," by S. J. Williams; "Asphalt Concrete Pavements," "Flood Protection at Dayton," and "Surface Treatment of Old Macadam." The secretary is Leonard S. Smith, Madison, Wis.

The Albany Society of Civil Engineers held its annual meeting on Jan. 25 at Keeler's Hotel, Albany. Among the speakers of the evening were Frank R. Lanagan, City Engineer of Albany, and Robert E. Horton. George A. Ricker was toastmaster. The officers elected for the ensuing year were: President, Rupert Sturtevant; vice-presidents, John E. Byron, Stephen B. Vernon and Roy G. Finch; treasurer, Horatio S. Mattimore; librarian, Wilber E. Anderson; and secretary, Ernest G. Raynor.

Engineers Society of Western Pennsylvania—The annual meeting of the society was held on the evening of Jan. 18 in the society rooms, Oliver Building, Pittsburgh. The following new officers were seated: President, Samuel E. Duff, Consulting Engineer; vice-president, W. E. Snyder, Mechanical Engineer, American Steel and Wire Co.; treasurer, Dr. Albert E. Frost, Registrar, University of Pittsburgh; directors, Henry B. James, Assistant Manager of Engineering, Westinghouse Electric and Manufacturing Co., and W. E. Mott, Professor of Civil Engineering in the Carnegie Institute of Technology. Dr. Frost was started on his thirty-sixth consecutive year as treasurer, having succeeded William Kent, author of the "Mechanical Engineer's Pocket Book." The usual reports of

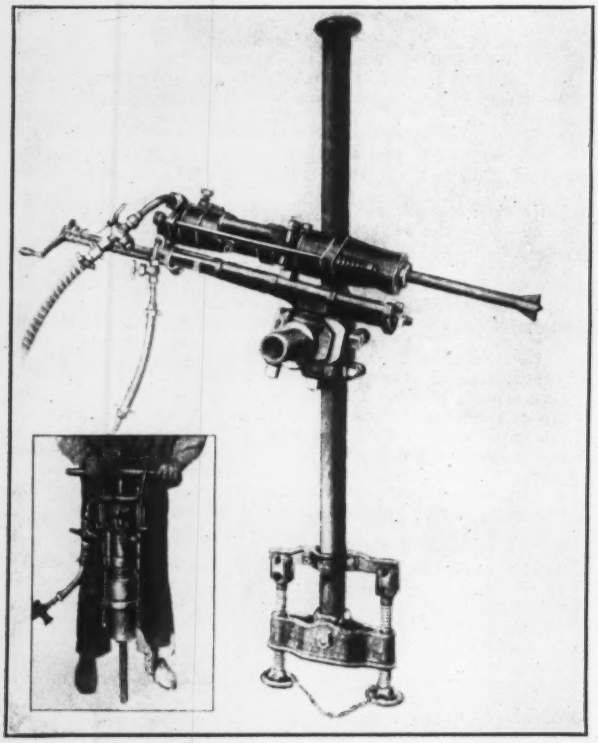
the mechanical, structural, metallurgical and mining sections were presented by their respective chairmen, besides reports of the standing and special committees. F. N. Speller reported for the Committee on Engineering Education, which conducts an annual competition in engineering problems participated in by students from a number of technical institutions; there were over 200 participating students this year. A committee has been working on the subject of getting a 100-ft. standard bar installed in the new City and County Building. Louis P. Blum, of the engineering firm of W. G. Wilkins Co., reported for this committee. Arrangements have been concluded with the officials of the city and county whereby a room 13x108 ft. has been set apart in the basement for the installation of a 100-ft. standard bar. Retiring President Stucki read an interesting address.

Appliances and Materials

New Light Rock Drill

A drill that may be used either mounted in a screw-feed shell or with a flexible handle to be manipulated by hand is the latest product of the Denver Rock Drill Manufacturing Co., of Denver, Colo. The drill uses hollow steel and is constructed to deliver air and water separately or simultaneously under pressure to the bottom of the drill hole. When wet drilling is not required, the water equipment may be replaced by a "blow-gun," which forces compressed air instead of water into the drill hole. The compressed air for blowing out chips is entirely independent of the air that drives the hammer.

The machine, which is called the "Dreadnought," is valveless and uses compressed air expansively. The hammer cannot strike either end of the cylinder, even when the drill steel is not against the rock, and full pressure can be turned on safely. Rotation is accomplished by mechanism located



"DREADNOUGHT" DRILL MOUNTED AND HAND-OPERATED

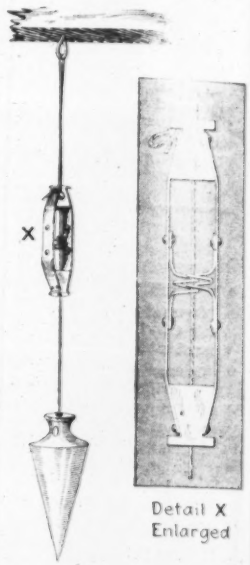
entirely in the front head. Two keys prevent the hammer from revolving in the cylinder, while rifling grooves on the reduced front part engage in the rifle-nut, turning the latter at each stroke. The chuck may be removed without dismounting the drill shaft. When equipped with the spring handle, the drill weighs 83 lb.; when mounted in its screw shell, the weight is 140 lb. The chucks furnished take 1⅛ and 1¼ steels. The drill proper can be removed from the feed shell by taking off two bolts. The drill has been tried out both in drifting and in shaft sinking, and is light enough [illegible] by one man in sinking.

* * *

Plummet Adjuster Saves Time

The time and energy wasted in tying and un[tying] in the plumb-bob string of a transit and by the [knots] these knots made such an impression on Clinton E. [Alexander] of Washington, D. C., that he has devised what [he calls] "Autoset Plummet Adjuster," which is just now ready for the market. Mr. Alexander states that when this adjuster is attached to the transit plumb-bob string, the plumb bob can be quickly shifted up or down with one hand while the other is shifting the transit head to position over the tack, or center point. This relieves the transitman from excessive stooping and bending and from tying and untying the knotted strings in order to obtain the proper plummet height.

The plumb bob is held true and positive at the height required by gripping the part of the plummet string that passes through the center of the adjuster. A slight pressure of the thumb and finger on the side springs releases the string and permits several feet of free up-and-down movement of the plumb bob while holding the adjuster, which grips instantly when the pressure is released. The adjuster will hold either a thick or a thin plummet string or a light or a heavy transit bob. It is manufactured and sold by the Autoset Co., 467 C St., Washington, D. C.



DEVICE FOR QUICKLY ADJUSTING TRANSIT PLUMB BOB

* * *

Combination Post-Hole Tool

To reduce the number of tools carried by a post, or pole, erection gang, a combination implement called the "Goheen Digger" has been devised by the Triple Tool Co., of Jacksonville, Ill. A simple curved blade with a hardened eye is pivoted to a steel-shod handle. The eye has three flat surfaces

"GOHEEN" POST-HOLE TOOL

against which a leaf spring in the handle bears, to hold the blade fixed on any one of three positions. The tool is used with the blade straight, as a spade; with the blade at right angles, as a spoon; and with the blade at 45°, for ditching.

* * *

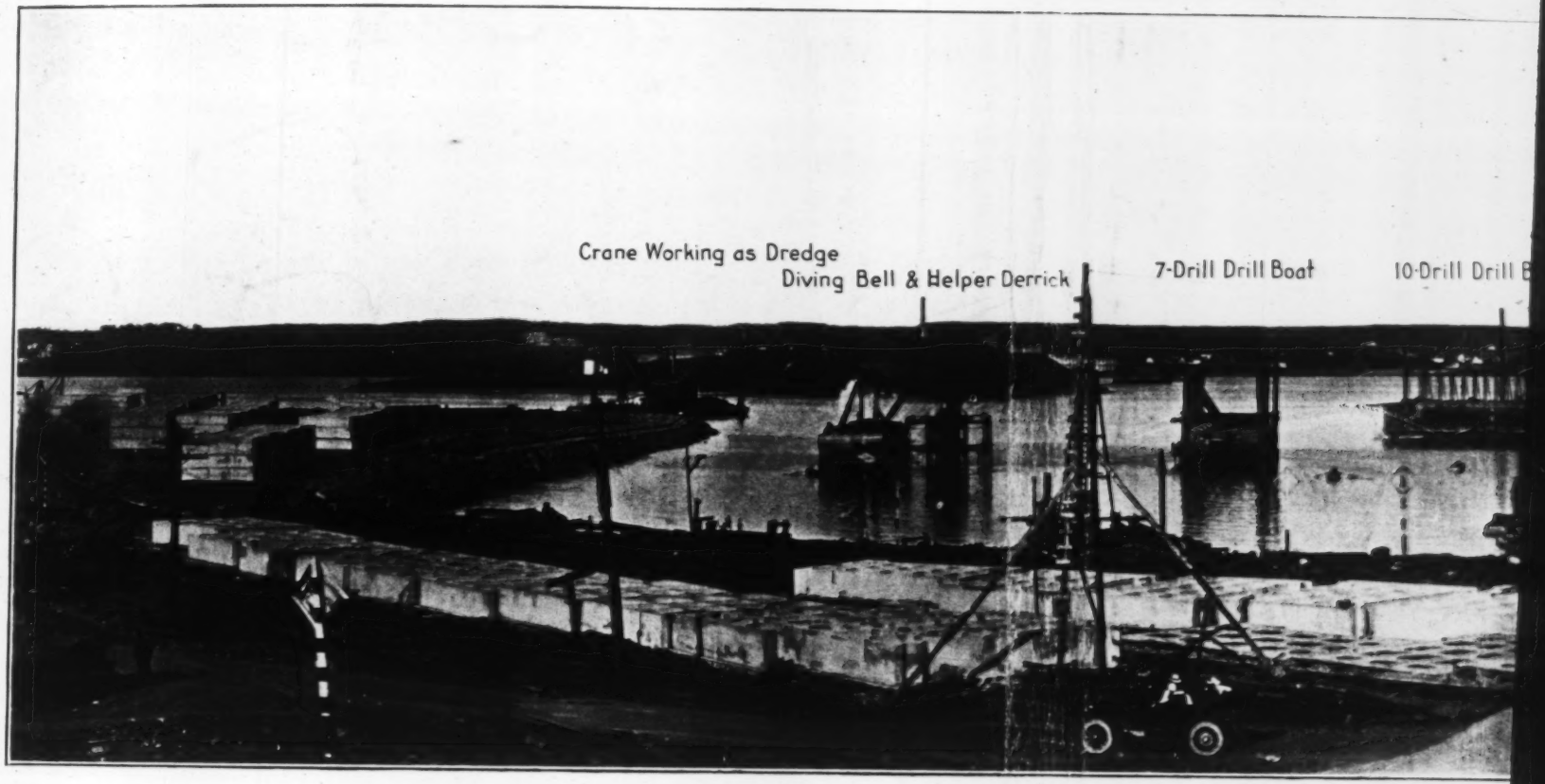
Portable Vise Stand and Bender

A handy portable vise, and rod or pipe bender has been put out by H. P. Martin & Sons, Owensboro, Ky. The stand body is made of No. 16 sheet steel braced with angles. The legs are of ¾-in. pipe and slip into sockets in the body. The front legs are nearly vertical to prevent interference with work; the rear legs are spread for stability. On the body are mounted a pipe vise and bending chuck, the latter acting also as a guide and rest for the former.

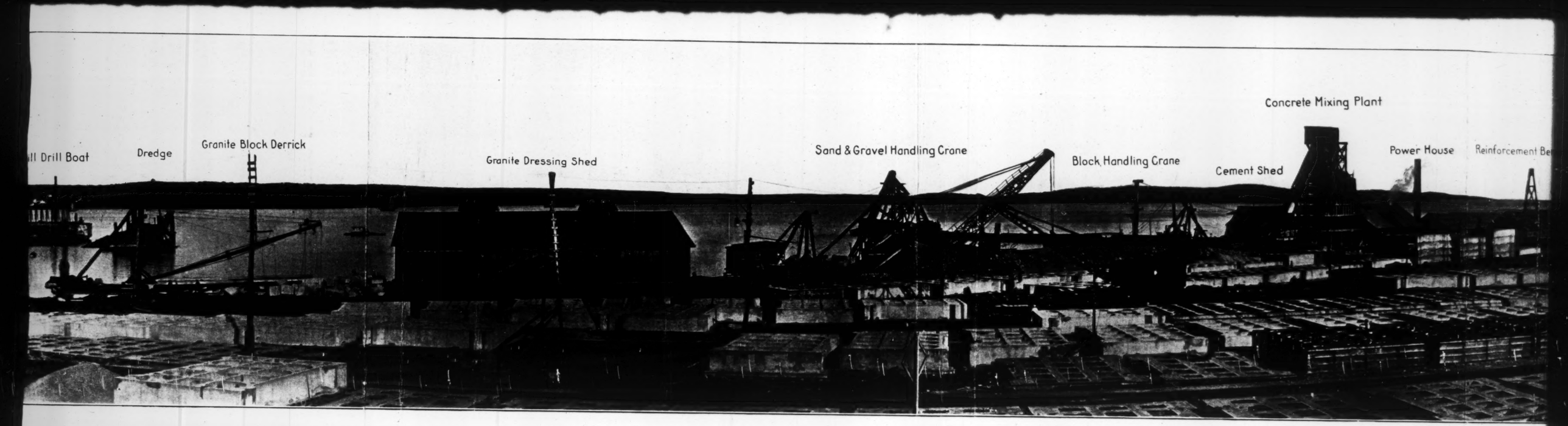
* * *

Pipe-Thawing Machine

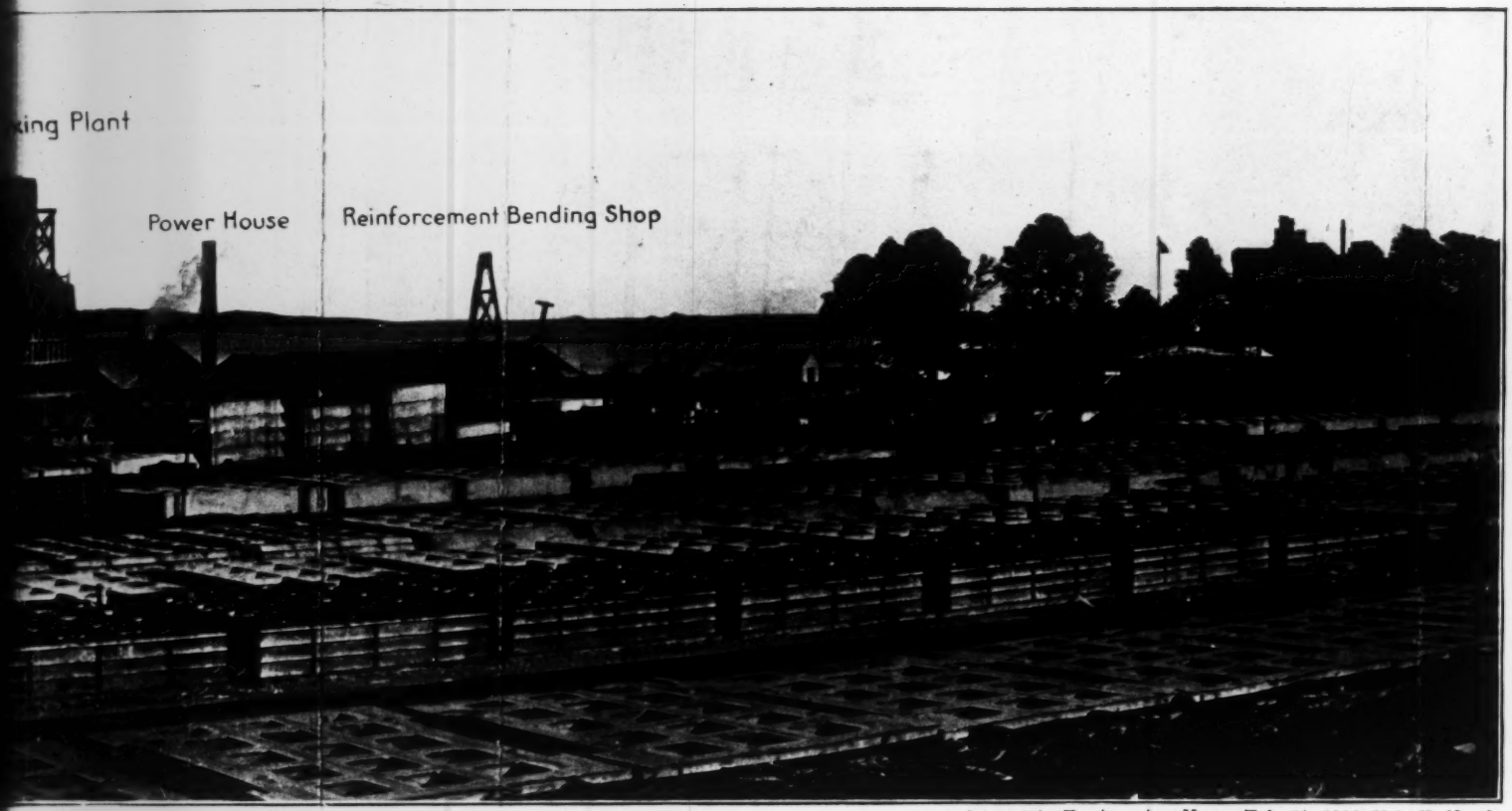
An outfit for thawing frozen house and service pipes, hydrants, sewers and conduits by a stream of hot water is being marketed by the Burbank Thawing Machine Co., 24 Custom House St., Boston. A force pump (with air chamber), pipe-coil heater, gasoline burner and fuel tank, are mounted on a single base plate. A flexible pipe leads the hot-water stream to a spray head, or nozzle. The whole outfit thus assembled weighs 125 lb.



Contractor's P



Plant for New Ocean Terminals Now Under Construction at Halifax, Nova Scotia



Supplement to Engineering News, Feb. 10, 1916, Vol. 75, No. 6.

Nova Scotia

Engineering News

VOLUME 75 FEBRUARY 17, 1916 NUMBER 7

Oldest Irrigation Conduit and Dam in the United States

On the meadows beside the lower San Diego River, half a dozen miles northeast of the City of San Diego, is the old San Diego mission. Here the Catholic missionaries, working northward from Mexico, established near the end of the eighteenth century one of the first outposts of civilization on the Pacific Coast in what is now United States territory.

In this arid region, with a rainfall averaging only about a dozen inches per annum, all occurring in the fall and winter months, irrigation is a prime necessity to agriculture. There still stand in a remarkably good state of preservation the dam and a large part of the conduit by which water was diverted from the San Diego River and carried some miles down its valley to the ranches surrounding the mission. There is little doubt that this dam and conduit are entitled to the distinction of being the oldest irrigation works in the United States, with the exception of course of the more or less primitive works for irrigation carried on by Indian tribes prior to European settlement. When one bears in mind the extreme limitations in means of transportation, in material, labor, and money with which these Catholic pioneers had to contend, the building of the old Mission dam and conduit was a remarkable achievement.

The dam, it should be explained, is purely a diverting dam and not a storage dam. The San Diego River in its course of some 50 mi. descends from elevations of 3,000 to 5,000 ft., and the river and its tributaries have eroded deep cañons in the soft rocks of the region. At its flood stages the river carries a very heavy burden of sand and silt, so that the pond back of any dam built across it is filled full with solid material during the first flood season.

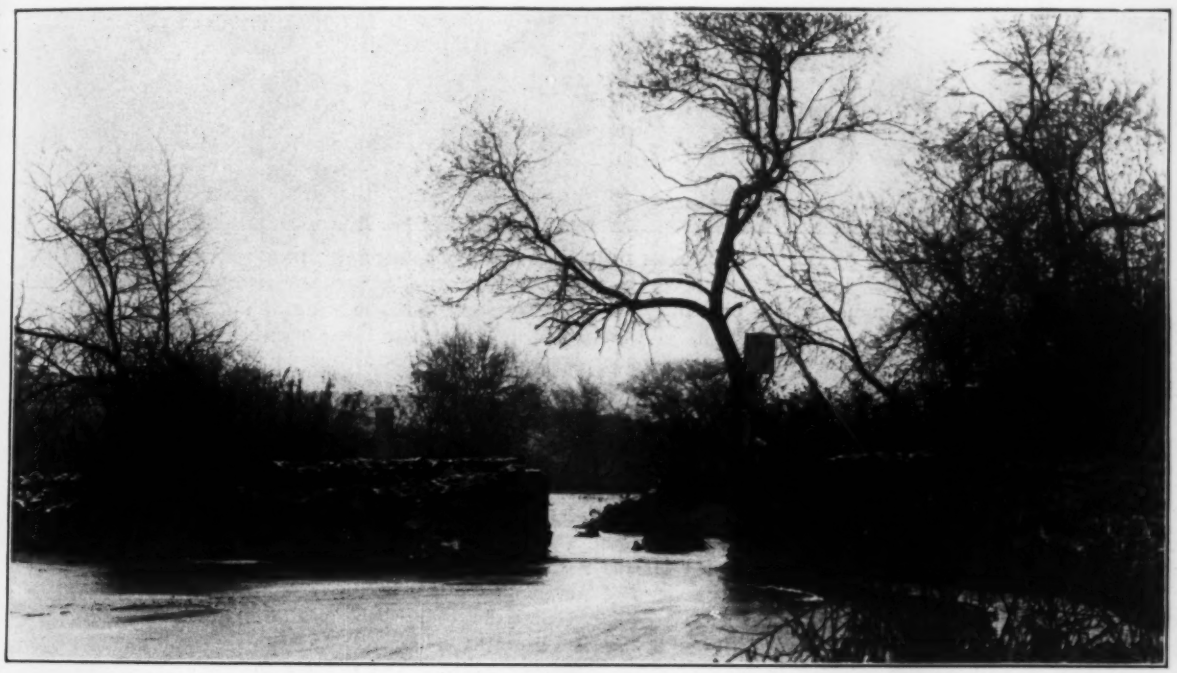


FIG. 1. THE OLDEST IRRIGATION DAM IN THE UNITED STATES, BUILT BY THE OLD MISSION OF SAN DIEGO, CALIF.

It is of interest in this connection to record that prior to 1850 the San Diego River carried annually vast quantities of silt into San Diego Bay and was rapidly filling up the present harbor of San Diego. It was due to the genius of a distinguished officer of the Corps of Engineers that San Diego harbor was saved for commerce. During the years prior to the Civil War, Lieut. Geo. H. Derby, of the Corps, who was stationed on the Pacific Coast, made himself famous by writing humorous papers which were published under the *nom de plume* of John Phoenix. Lieutenant Derby proved that he was as com-

FIG. 2. VIEW OF OLD MISSION DAM DURING A FLOOD IN THE SAN DIEGO RIVER

petent an engineer as a humorist by diverting the course of the San Diego River at its mouth, so that instead of discharging into San Diego harbor it was made to empty into what is known as False Bay, a shallow body of water located to the north of San Diego Bay and separated from it by a high sand ridge.

The old Mission dam and the conduit, as may be seen by the accompanying illustrations, were built of a curious combination of rough rubble masonry and very large, thin tile. The mortar used was of course lime mortar and must have been burned in kilns established for the purpose near-by. As may be judged from the views of the dam and of the flood which it annually sustains, this lime-mortar masonry has lasted remarkably well. The central opening in the dam, seen in the view, doubtless originally contained a wooden controlling gate which was left open in time of flood and was closed only when it was desired to divert the water into the irrigation conduit, which connected with the dam near its north end.

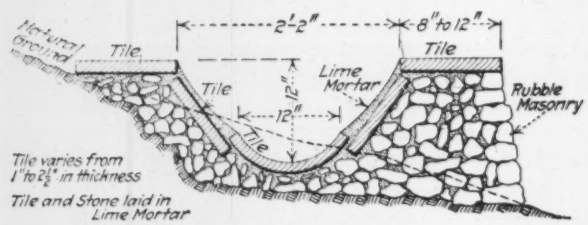


FIG. 3. TYPICAL CROSS-SECTION OF OLD MISSION CONDUIT NEAR SAN DIEGO, CALIF.

One reason for the location of the dam at this point is that the river here flows over bedrock at the head of a long cañon, so that all the flow down the valley is intercepted by the dam. In recent years the dam has been used as a river-gaging station by the United States Geological Survey.

From the dam the masonry conduit follows down the north bank of the river about three or four miles to the lands around the old mission. Much of the conduit is still plainly visible from the highway on the opposite bank. The construction of the conduit is shown in the accompanying cross-section drawing. Over a part of its course, however, the conduit was in excavation and appears to have been merely lined with masonry. The size of the tiles used for lining is particularly noteworthy and evidences the considerable ability of these early pioneers in the art of pottery manufacture and in utilizing Indian labor for this more or less technical work.

Engineering News is indebted to F. M. Faude, Assistant Manager of the Cuyamaca Water Co., for the accompanying photographs and cross-section drawing of these old irrigation works and for courtesies extended to a member of the editorial staff on a visit to them.

⁂

The Expenses of the City Engineer's Department of Providence, R. I., for the year ending Sept. 30, 1915, so far as shown by bills actually paid, were distributed as follows: Salaries of city engineer and assistant engineers, $52,516; salaries of clerks, $4,705; supplies, including drawing materials, $3,016; carfares, $1,517; instruments and repairs, $334; telephone lines, $238; sundries, $22; meteorological instruments and repairs, $10; carriage hire, $6; total, $62,374.

County Engineering in Kansas

EDITORIAL CORRESPONDENCE

The present road and bridge laws of Kansas (passed in 1909) are so deficient that the position of county engineer is anything but an easy one. The difficulties of this office have been discussed at several annual meetings of the Kansas Engineering Society, and at the most recent one the county-engineer members of the society formed a committee, or organization, to seek remedial legislation.

While the present law establishes the office of county engineer (optional with the county) and defines his duties as the general supervision of road and bridge work, the actual effect of the various provisions is to make him entirely subordinate to the county commissioners, who may or may not follow his advice and directions and who may at any time dispense with his services altogether. With tact and popularity the engineer may accomplish something, but these are his only means.

In spite of these drawbacks and the fact that the salaries range from $400 to $1,200 a year, several technically trained young engineers are devoting their best efforts to this work. Their field is a large one, if it is considered that there are 108,500 mi. of highways in the state, all dirt or gravel roads, and that about 0.5% of the area of the state is in streams of various sizes.

The bridges over some of these streams are remarkable creations. If one wishes to see the laws of mechanics defied, let him take a trip over some of these Kansas highways. In the county surveyor's office at Abilene are plans showing recent measurements of three bowstring truss bridges, which have been in service since the seventies. One of these bridges has spans of 168 ft., with approximately 9-ft. panels, but with no two panel lengths the same and with the lengths of opposite panels differing from each other by as much as 6 in. It is impossible to tell whether the bridge was so constructed or whether its members have "stretched." The top chords are of remarkably light section, and the laterals are all rods. These bridges have wood stringers, and the problem is to replace them without adding to the dead load.

The accompanying illustration is another type of bridge quite popular in this county until recently. The farmer who tried to take a traction engine over it had about as much knowledge of mechanics as the farmers who constituted the board of county commissioners that built it. A number of these bridges, however, have been made to serve by riveting two 3½-in. angles to the top chord.

These county bridges have been built under trustee commissioners, appointed by the county commissioners. Such a trustee, or bridge, commissioner must reside in the township, and his duty is (quoting the law) "to proceed to the spot where the bridge is to be built, and make an accurate estimate of the cost according to any plan or plans ordered by the county commissioners, or such as in his opinion may be best." Upon such data bids are advertised and contracts let to the lowest bidder. This bridge commissioner receives the munificent salary of $1.50 per day. The bridge is accordingly built "under the supervision" of a superintendent appointed by the county commissioners, who also receives $1.50 per day.

There is a growing sentiment in the state in favor of a large bond issue (generally put at $25,000,000) for good-roads construction, but it is obvious that the first step is to educate the farmers to the value of engineering service and advice. Since the townspeople of Kansas are already so progressive that there is not a city of over 1,000 population without water-works, none of over 2,500 population without a sewer system and many cities under 1,000 population with paved streets, the time is probably not far distant when there will be good county roads and bridges as well.

The rocky pathway of the county engineer under the present system is aptly summarized as follows in a paper by R. F. Gallup, county engineer of Marshall County:

> The engineer's success will depend not only upon his technical and practical training, but also in a measure upon his ability to solve the human equation. No man liveth to himself alone, and certainly not the engineer, whose work is almost entirely connected with the public welfare. From day laborer in the foundation pit to the head of a bridge company, from road boss to county commissioner or mayor, he will be alternately commended and censured, and he must keep his equilibrium through both praise and blame. The progressive man will be quick to profit by helpful criticism, no matter from what source it comes, and then knowing himself to be right, go ahead. Diplomacy is necessary, but not to the extent of being wafted about by every breeze of public opinion. He must carry a "gentleman's manner with a rhinoceros' hide."

A KANSAS COUNTY BRIDGE TESTED BY A TRACTION ENGINE

Making and Laying Home-Made Pipe for Water Mains

Plymouth, Mass., has the practically unique distinction of manufacturing all the pipe which has been used for its water mains. The policy of using exclusively sheet-iron or sheet-steel cement-lined pipe was adopted many years ago (in 1855) and has been followed consistently ever since. In 1900 the town water department built a specially designed plant for making this pipe as a part of its water-works routine.

Plymouth has a comparatively small population (about 12,000), and the water pressures are not high—from 30 to 70 lb. per sq.in. While the water-works superintendent does not by any means recommend the universal use of cement-lined, sheet-steel water-mains, there seems to be no question of its satisfactory service and economy in Plymouth. It is not unlikely that in many localities where freight rates on cast-iron pipe make it almost prohibitive, home-made cement-lined pipe would be a simple and economical solution of the distribution-system problem.

The original pipe, of which there is still a large amount in use, consisted of a sheet-iron shell about 9 ft. long, lined on the inside with about ½ in. of cement mortar mixed 1:1. The pipe was laid on a bed of mortar in the trench with the ends simply butted together and covered with a steel sleeve, or collar, afterward incased in mortar. The top and sides of the pipe were then covered with 2 in. or more of mortar, all of the same proportions as the lining—1:1 cement and sand. A part of one of these mains which had been in continuous use for 60 yr. was dug up Oct. 4, 1915, in the presence of one of the editors. It was in perfect condition inside and out.

Method of Manufacturing Cement-Lined Pipe

The water-works shop built in 1900 is equipped with machinery and facilities for making pipe according to the Phipps patented method. Since then, mains up to 30 in. in diameter have been manufactured. This new pipe consists of a shell, a jacket, male and female end rings and sleeves. The shells and jackets are made of rectangular plates of soft steel, the gage depending on the diameter of the pipe. For 24-in. pipe the gage is 12; 18-in. pipe, 13; 16-in., 13; 12-in., 15; 10-in., 17; 8-in., 18; 6-in. 19; 4-in., 20. The jackets are all of 26-gage wrought iron.

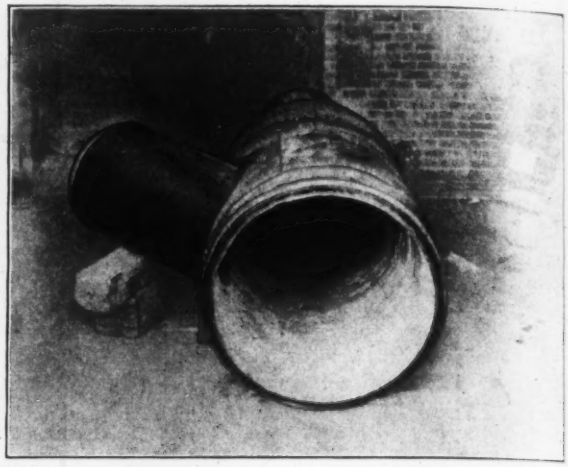


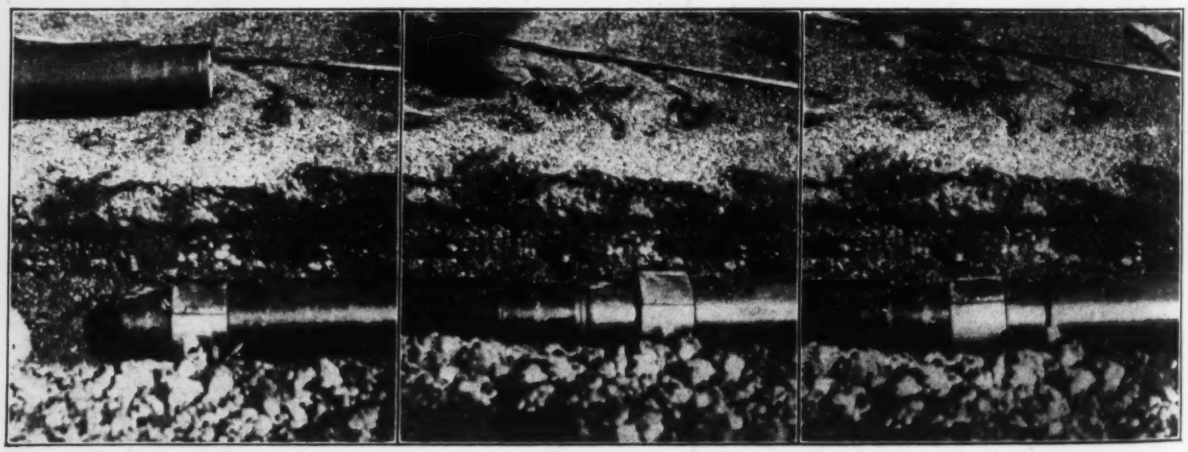
FIG. 1. A "SPECIAL" OF CEMENT-LINED SHEET-STEEL WATER PIPE

The plates for the shell are punched in a machine which makes the two rows of holes simultaneously. The holes are spaced ¾ in. c. to c., the edge of the holes being ⅝ in. from the edge of the plate. When the punching is completed, the plate or plates (two for the larger sizes of pipe) are bent to the approximate radius required, by running them through steel rolls. The plates are then riveted together by hand on a bench, or "stake," the top of which is shaped to approximately the curve of the interior of the pipe. The jacket plates are handled in the same manner, making cylinders 1½ in. larger in diameter than the shells.

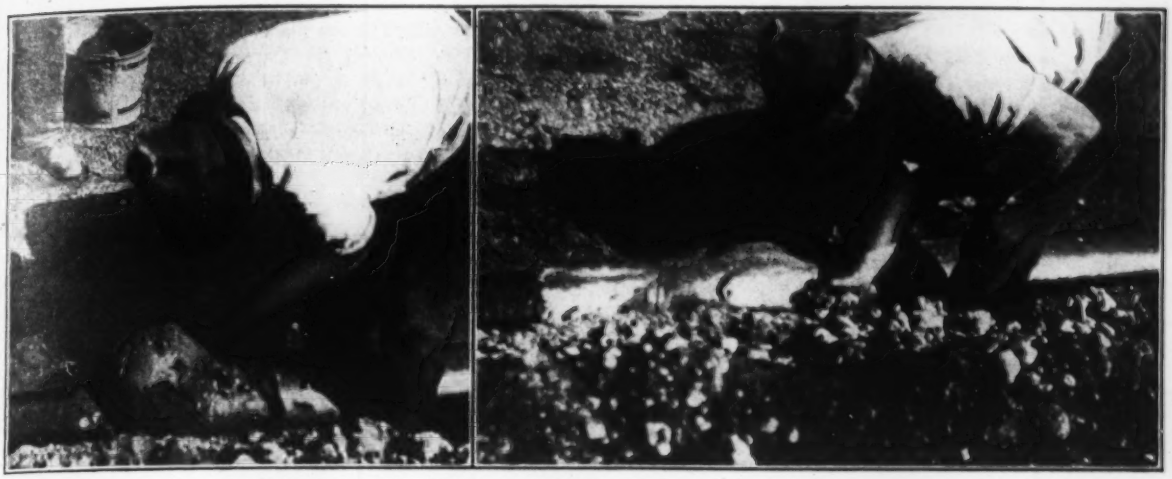
The end rings are of the best grade of cast iron; a male, or convex, ring is driven into one end of the shell and a concave, or female, ring into the other end. The thickness of the ring castings on the inside of the pipe is the same as that of the cement lining.

Lining the Shells with Cement Mortar

The lining of the pipe is accomplished by a simple machine, the essentials of which are an elevator and a revolving cylinder, or since it is slightly tapered, a "cone." The shell is placed on the elevator platform over the pit containing the cone, the top of which ex-



FIGS. 2 TO 4. STEPS IN MAKING THE JOINT IN CEMENT-LINED SHEET-STEEL WATER MAIN



FIGS. 5 AND 6. COVERING THE JOINT WITH NEAT CEMENT MORTAR

tends into the shell far enough to prevent the mortar lining from falling through. The mortar is mixed on the floor above by machine. It is made of neat Rosendale cement and water. The cone is started revolving, and the batch of mortar is dumped into the top of the pipe shell, which is then lowered on the elevator over the revolving cone. The elevator is raised again, the pipe removed and the rough places and final finish given by hand tools.

When the cement lining has properly set, the shells are stood on end alongside an elevated platform and the jackets placed over them. A special clamp is used to hold the bottom of the jacket, and four wedges hold its top in place. The space between the jacket and the shell is filled with a very wet grout of neat cement. The mixing is done on the same machine as for the lining, and the grout is conveyed in a traveling steel bucket. The pipe is then allowed to stand for 24 hr.

Making Joints—Tests of Old and New Joints

When properly cured, no difficulty is experienced in handling the pipe. It can be rolled off a wagon without injury. In laying the pipe the end rings are wedged together as tightly as possible. The joint is then plastered over with mortar, and a sleeve of the same gage iron as the shell is pushed over the connection. The whole connection is then plastered over with two or more inches of neat cement mortar (see accompanying illustrations, especially Figs. 5 and 6.)

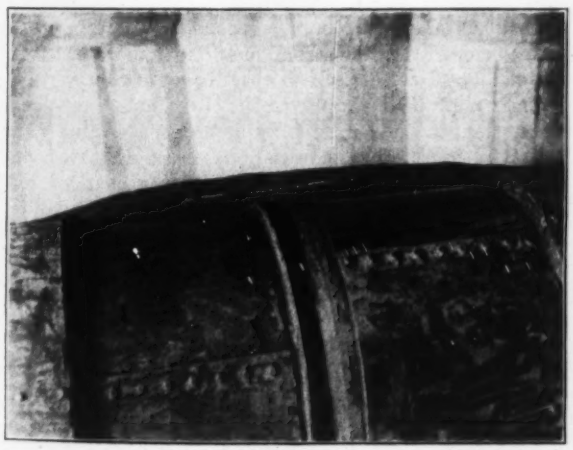


FIG. 7. COMPLETED JOINT IN CEMENT-LINED MAIN WITH CONCRETE COATING REMOVED

Tests of a 50-yr.-old 10-in. main 7,500 ft. long have shown a leakage of 9,550 gal. daily, or 1.4 gal. per lin.ft. of joint per day. Tests of a 25-yr.-old main 9,300 ft. long, half of it 16 in. and the other half 14 in. in diameter, have shown a leakage of 2.3 gal. per lin.ft. of joint per day. The joints are undoubtedly the weakest part of the old-style pipe, but tests of new joints in the new type of pipe show very little leakage under testing pressures of 150 lb. per sq.in.

Cost Data on Cement-Lined Pipe

The cost of making this pipe does not differ greatly from the cost of cast-iron pipe delivered at Plymouth under the prevailing prices. There are times, however, when there has been considerable economy in the cement-lined mains. The soil of Plymouth is dry and sandy, and there is no corrosion from the outside. On the inside of the mains there is never any trouble from tubercles or other incrustations, and the pipe maintains its maximum carrying capacity indefinitely. The loss of head from friction is of course more than in new iron pipe.

The cost of making 16-in. pipe in 1907 was $1.24 per lin.ft., including the joint sleeves. In 1908 the cost of making 7,424 ft. of 18-in. pipe was $10,714.78, or $1.44 per lin.ft. In 1910 the cost of making 8-in. pipe was 52½c. per lin.ft.; 6-in., 38.2c. per ft.; and 4-in., 27.6c. These costs do not include the cost of sleeves for the 4- and 6-in. sizes. The cement-lined pipe is lighter than cast-iron pipe, and the cost of handling and laying is less, if anything, than that for cast-iron pipe.

Records of Maintenance Costs—Making Taps

A record of the mains since 1905 is as follows: There were then 46¾ mi. in use (2- to 20-in.), the number of leaks per mile was 0.87, and the cost of repairs per mile was $11.02. In 1906 there were 47¼ mi. in use, 0.53 leak per mile, and the cost of repairs per mile was $6.67. In 1907 there were 49½ mi. in use, 0.52 leak per mile, and the cost of repairs per mile was $12.56. In 1908 there were 51½ mi. in use, 0.64 leak per mile, and the

cost of repairs was $7.71 per mile. In 1909 there were 52¼ mi. in use, 0.96 leak per mile, and the cost of repairs per mile was $12.43. In 1910 there were 53¼ mi. in use, 0.43 leak per mile, and the cost of repairs per mile was $3.71. In 1911 there were 53½ mi. (2- to 30-in.) in use, 0.03 leak per mile, and the cost of repairs per mile was $3.50. In 1912 there were 54 mi. in use, 0.44 leak per mile, and the cost of repairs per mile was $4.37. In 1913 there were 54½ mi. in use, 0.28 leak per mile, and the cost of repairs per mile was $4.47. In 1914 there were 55¼ mi., 0.25 leak per mile, and the cost of repairs was $2.20 per mile. These figures show a decreasing number of leaks and a decreased cost of maintenance, as much of the older pipe was replaced. The average number of leaks per mile for the whole 10-yr. period is 0.495, and the average cost of repairs per mile is $6.86.

No difficulty is experienced in making taps in this type of water main. The jacket is cut away with a cold chisel, and the intervening cement down to the shell is chipped away in the same manner. Tapping through the shell and lining and the placing of the corporation cock are then performed in the usual way.

The superintendent of the Plymouth water-works is Arthur E. Blackmer.

Lost-Head Diagrams for Bends in Water Pipe

By Ben Moreell*

Numerous formulas for the determination of the hydraulic head lost in a circular bend in a water pipe have been proposed from time to time. These formulas are based either upon a theoretical consideration of the mechanics of the problem or upon the author's "judgment," the latter of which may be classed as mere arbitrary assumptions. The desirability of establishing a uniform standard of practice which shall conform as closely as possible with all of the known facts led the writer into an investigation of this subject. The resulting conclusion was that theoretically there is no loss of head in water flowing around a bend and that any compensation for the loss which is known to occur should be based upon the results of actual experiments.

The first reliable recorded experiments are those of Williams, Hubbell and Fenkell on 12-, 16- and 30-in. water mains of Detroit, Mich., with velocities up to 5.8 ft. per sec. Later, experiments were made by Saph and Schoder at the Cornell hydraulic laboratory, G. J. Davis at the Wisconsin hydraulic laboratory, C. W. Alexander at the University of Birmingham and W. A. Brightmore. These later experiments were performed on 2- to 6-in. pipes, with velocities up to 16 ft. per sec.

We have also a table of constants established by Weisbach, based on the results of his own experiments and those of Dubuat. These constants are to be substituted in the equation

$$lost\ head = C\frac{v^2}{2g}$$

and vary with the radius of curvature of the pipe.

Before entering upon a discussion of the results obtained, it might be well to investigate the "character" of the loss which takes place at a bend. The work of Saph and Schoder at the Cornell laboratory shows this quite clearly. Figs. 1 and 3 show velocity contours in straight and curved portions of a 2-in. brass pipe. Although the average velocity in all cross-sections of a pipe line of the same diameter throughout must be the same $\left(v = \frac{Q}{A}\right)$, it is evident from an examination of Figs. 1 and 3 that the average velocity next to the sides of the pipe in curve-distorted flow is greater than in normal flow, causing a greater loss in head due to friction on the pipe wall. This consideration leads us to the conclusion that the loss of head due to curvature is caused (1) by the resistances produced by distortion in the interior of the stream, causing boils and counter-currents even in a perfectly smooth pipe, and (2) by the increased frictional resistance on the sides of the conduit, due

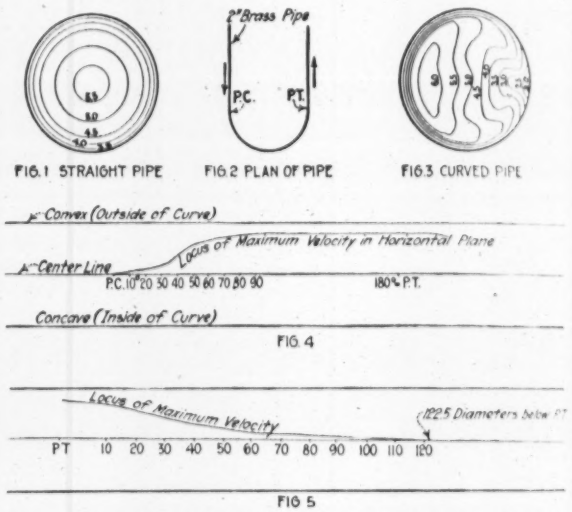

2" Brass Pipe
P.C.
P.T.
Convex (Outside of Curve)
Locus of Maximum Velocity in Horizontal Plane
Center Line
P.C. 10° 20 30 40 50 60 70 80 90
180° P.T.
Concave (Inside of Curve)
Locus of Maximum Velocity
122.5 Diameters below P.T.
PT 10 20 30 40 50 60 70 80 90 100 110 120

FIG. 1 STRAIGHT PIPE FIG. 2 PLAN OF PIPE FIG. 3 CURVED PIPE

FIG. 4

FIG. 5

FIGS. 1 TO 5. EFFECT OF CIRCULAR BENDS ON FLOW OF WATER IN PIPE

to the shifting of the maximum velocity from the center toward the outside of the curve.

Figs. 4 and 5 show the locus of the positions of the maximum velocity in the plane of the horizontal diameter of the pipe. As the water strikes the P. C., the position of the maximum velocity begins to move toward the outside. At 50° from the P. C. it is found that the distortion has practically been completed. There is no appreciable change in the second quadrant, the water having thoroughly adjusted itself to curvilinear motion.

The water, having traversed the curve, enters the downstream tangent under its fully distorted condition (Fig. 5). The equilibrium, however, has been destroyed, and the water gradually adjusts itself to the changed conditions until at 122.5 diameters downstream from the P. T. the condition of normal flow in a straight pipe has been attained. It is thus evident that a considerable portion of the loss due to a bend takes place in the straight portion of pipe downstream from the curve.

In all of the experiments performed, the results seem to indicate that for any given velocity, the lost head in a circular bend of a certain angle is proportional to the radius of curvature of the pipe, the ratio of radius of bend to diameter of pipe, $\frac{R}{D}$. The experiments have all been performed on bends of 90° with various radii.

*Assistant Engineer, City Hall, St. Louis, Mo.

Although it seems reasonable to suppose that the excess loss in a bend would depend in some measure upon the nature of the material of which the conduit is made, the results obtained by the various investigators for the same material vary more than do those obtained by one investigator for different materials. With the limited data at hand it seems best to neglect for the time being any variation due to differences in the nature of the conduit surface.

The plan of the writer was to obtain curves from which, having given the ratio $\frac{R}{D}$ and the velocity, the designer could pick off the excess lost head due to the bend. The method employed was to plot for each velocity all of the results which could be obtained from the published data (Figs. 6 to 10).

No use was made of the data of Williams, Hubbell and Fenkell, or of Alexander. The Detroit experimenters found that for $\frac{R}{D}$ greater than $2\frac{1}{2}$, as the ratio of $\frac{R}{D}$ increased, the loss increased instead of decreasing, as found by all of the other experimenters. In looking for the cause of the disagreement, the following facts may be noticed:

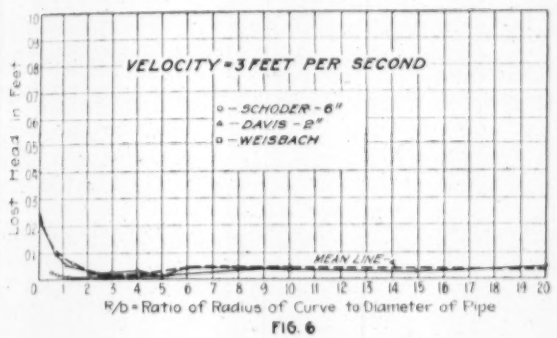
(1) The extreme smallness of the measured losses, combined with the comparatively low velocities available (the greatest about 3.5 ft. per sec. in the 30-in. pipe), would tend to magnify excess losses due to other effects than curvature.

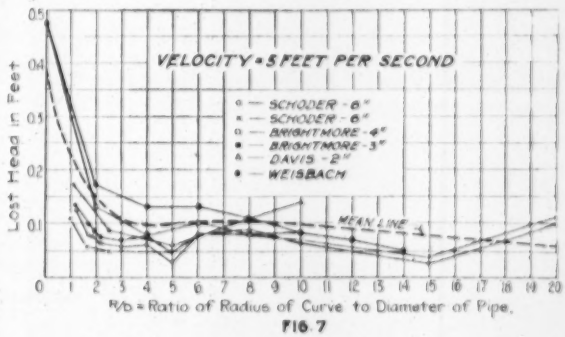
(2) The upstream piezometers were placed where they would be affected by curves in the previous section.

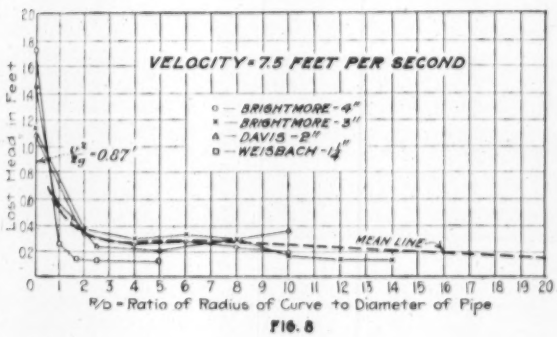
(3) The downstream piezometers were placed too near to the P. T. of the curve to measure the total loss.

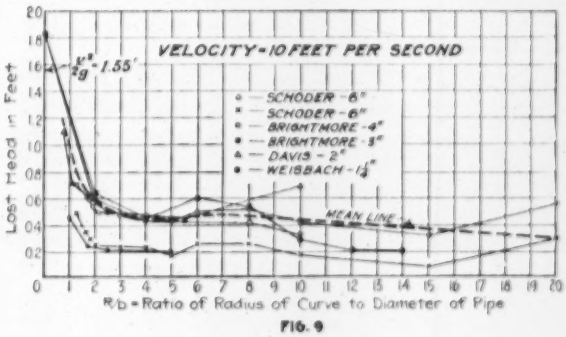
In the light of the foregoing observation, it was decided to omit these experiments from consideration, especially as they would aid in determining only the 3- and 5-ft. velocity curves (for which there are already good data), whereas our maximum is 16 ft. per sec.

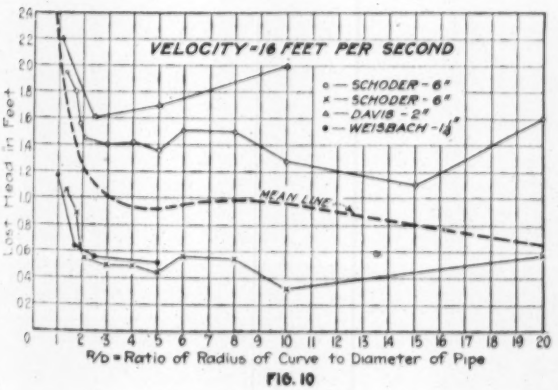
In Alexander's experiments the curves were made of wood coated with shellac, while the adjacent tangents were made of cast-iron pipe of the same diameter. As he himself points out, the connection of the cast-iron pipe

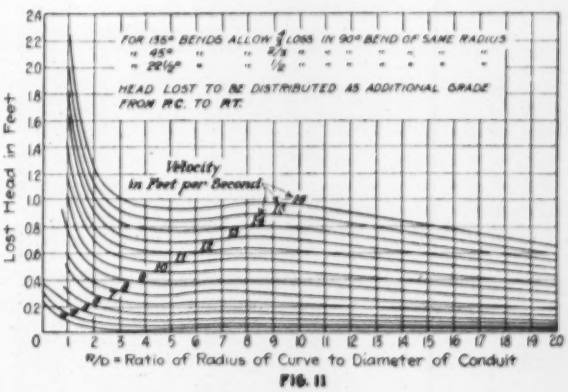

VELOCITY = 3 FEET PER SECOND
o — SCHODER - 6"
Δ — DAVIS - 2"
o — WEISBACH
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 6


VELOCITY = 5 FEET PER SECOND
o — SCHODER - 6"
× — SCHODER - 6"
o — BRIGHTMORE - 4"
• — BRIGHTMORE - 3"
Δ — DAVIS - 2"
• — WEISBACH
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe.
FIG. 7


VELOCITY = 7.5 FEET PER SECOND
o — BRIGHTMORE - 4"
× — BRIGHTMORE - 3"
Δ — DAVIS - 2"
□ — WEISBACH - 1¼"
V²/2g = 0.87'
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 8


VELOCITY = 10 FEET PER SECOND
V²/2g = 1.55'
o — SCHODER - 6"
× — SCHODER - 6"
o — BRIGHTMORE - 4"
• — BRIGHTMORE - 3"
Δ — DAVIS - 2"
• — WEISBACH - 1¼"
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 9


VELOCITY = 16 FEET PER SECOND
o — SCHODER - 6"
× — SCHODER - 6"
Δ — DAVIS - 2"
• — WEISBACH - 1¼"
MEAN LINE
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Pipe
FIG. 10


FOR 135° BENDS ALLOW ¾ LOSS IN 90° BEND OF SAME RADIUS
" 45° " " ⅔ " " " " " " "
" 22½° " " ½ " " " " " "
HEAD LOST TO BE DISTRIBUTED AS ADDITIONAL GRADE FROM P.C. TO P.T.
Velocity in Feet per Second
Lost Head in Feet
R/D = Ratio of Radius of Curve to Diameter of Conduit
FIG. 11

FIGS. 6 TO 11. DIAGRAMS SHOWING LOSS OF HEAD DUE TO 90° BENDS IN WATER PIPE

In Fig. 6 the average values for "n" in Kutter's formula for "C" are: Schoder's 6-in. pipe, 0.009; Davis' 2-in., 0.008; Brightmore's 4-in., 0.0158; Brightmore's 3-in., 0.007

to the wooden bend increased the disturbance at the bend considerably, and also his piezometers were not placed so as to give the total loss due to the bend. For this reason no use was made of these experiments.

Figs. 6 to 10 show the plotting of the data of the various experimenters, together with the mean line for each velocity, as estimated by the writer.

Diagram for Velocities Up to 16 Ft. per Sec.

Fig. 11 shows the assembling of the mean lines, together with the interpolated values for velocities up to 16 ft. per sec. It must be borne in mind that the curves thus drawn are for 90° bands. Referring back to Figs. 4 and 5, we see that very little distortion takes place in the second quadrant of the 180° curve. Weisbach found that adding 90° to a 90° curve of the same radius only increased the resistance about 40%. The increased resistance was no doubt due to the greater length of pipe over which the maximum velocity was shifted toward the wall, thus increasing frictional loss.

Weisbach also found that when a tangent was introduced between two curves turning in the same direction the loss of head added by the second curve was increased, for as soon as the water reaches the tangent, the distortion begins to reduce itself; and the water not only has to be redistorted in the second curve, but energy is absorbed in the readjustment in the tangent. It seems reasonable to assume that if the tangent separating the curves is not sufficiently long to allow the curve distortion to be entirely eliminated, the full loss due to both curves will not be occasioned. We have no experiments to guide us in allowing for this condition.

When a reversal of curvature takes place, the loss which would normally occur in the downstream tangent of the first curve is evidently eliminated. However, the sudden shifting of the position of maximum velocity from one side of the conduit to the other, with the accompanying increase in eddy action, would no doubt tend to counteract the apparent gain due to the elimination of the first downstream tangent. For this reason it seems fair to assume that in the case of a reverse curve the full loss for each curve should be allowed.

Although Schoder found in his experiments on 6-in. pipe that the condition of curve-distorted flow was wiped out at a distance of 76 diameters downstream from the P. T., it seems best in the case of a conduit operating at flow-line grade to distribute the lost head due to curvature as additional grade from the P. C. to the P. T. The result will be that a portion of the straight conduit below the curve will flow under a slight head (if the conduit is assumed flowing full), which is in general not a serious condition.

Suggested Rules for Computation

In the light of the foregoing considerations, the writer suggests the following rules:

(1) For bends of 90° the lost head is to be obtained from the curves shown in Fig. 11.

(2) For bends of 45° allow two-thirds the loss of a 90° bend of the same radius; for 22½° allow one half of the 90° loss and for 135° allow four-thirds of the 90° loss.

(3) For curves turning in the same or opposite directions the best condition for flow is obtained when a minimum length of tangent separates the curves.

(4) The curve compensation in the case of a conduit operating at flow-line grade is to be distributed as additional grade from the P. C. to the P. T. of the curve.

The writer realizes the fallacy of applying the results obtained by experiments on pipes of 2-, 3-, 4- and 6-in. diameter to the larger sizes of conduits, but until some tests upon the the larger sizes are available, we are compelled to use the existing data. The uncertainty in fixing the exact position of the lost-head curves for the higher velocities, as indicated in Fig. 6, emphasizes the lack of conclusive experimental data and indicates that there is still a great need for investigation upon this subject.

Massachusetts Sand-and-Oil Road Experience*

By W. R. Farrington†

The first sand-and-oil road in Massachusetts was constructed by the state highway commission on Cape Cod, in 1905, in the town of Eastham. The "California method" was first followed, but before the completion of the road the "layer method" was adopted.

Some experiments were made with mixed sand and oil for road surfaces in 1908, but the first mixed sand-and-oil surfaces of any extent were laid in Wareham and Rochester in 1909. The layer sand-and-oil roads have therefore been in use in this state for some 10 yr., and the mixed sand-and-oil surfaces for 6 yr.

The construction of the road in Eastham and of a similar road in the adjoining town of Orleans demonstrated, however, that the California method was not economical and did not give the best results. Various experiments were made and the layer method finally evolved, the roads being completed by this method.

Road Construction by Layer Method

In constructing a road by the layer method the subgrade is shaped and any sandy places hardened. Either 1½ gal. of hot oil in two applications or 2 gal. in three applications is put on. Sand is spread over the oil after each application and the road rolled with a horse roller, it being well to do the final rolling with a steam roller if one is available.

With the ¾-gal. application of oil about 1½ in. of sand is used for covering, and with the ⅔-gal. application about 1¼ in. The 1½-gal treatment should give eventually a thickness of about 3½ in., and the 2-gal. treatment about 4 in.

If it is desired to confine to one season all work on the road properly chargeable to construction, 2 gal. of oil should be used; otherwise it is advisable to use only 1½ gal. the first season and to apply another ½ gal. the following spring. Experience has demonstrated that any surface constructed of sand and oil by the layer method will be more or less out of shape for some time after the oil is applied and that weak places will develop. It is principally for this reason that it is more satisfactory and economical to delay the application of the last ½ gal. of oil until the second season. By this method it is possible to find and strengthen any weak places and to re-

*Abstract of a paper presented before the Boston Society of Civil Engineers, Jan. 26, 1916.

†Division Engineer, Massachusetts Highway Commission, Boston, Mass.

move any inequalities in the surface by scraping with a road machine before the final application of oil.

A clean, sharp and fairly coarse sand will give the best results, but a comparatively fine sand, even one containing a small proportion of clay or loam, will give good results with the proper grade of oil.

The surface of a sand-and-oil road constructed by the layer method should have a crown of not over ½ in. to the foot and should be at least 15 ft. wide; from 16 ft. to 18 ft. is a more satisfactory width unless the shoulders are hardened, as the edges of the sand and oil will be broken down rapidly if there is any considerable amount of turning out onto soft shoulders.

The cost of the surface of sand-and-oil roads constructed by the layer method has varied from 21 to 33c. per sq.yd., the average cost being 26c. per sq.yd. This cost does not include grading, culvert work, etc., but does include shaping the subgrade.

Constructing Mixed Sand-and-Oil Roads

In constructing a mixed sand-and-oil surface the subgrade is shaped and, if sandy, is hardened with the best material available, usually sandy loam or clay. The sand and oil are heated to the proper temperatures and mixed by hand or by machine. If by hand, the mixing is done on platforms with rakes and hoes, or by turning with shovels. The mixing is continued until all the grains of sand are coated with oil. For this work, from 15 to 25 gal. of oil or oil asphalt has been used per cubic yard of loose sand, but ordinarily the best results have been obtained by the use of about 16 gal. per cu.yd. of sand if loose, or about 18 gal. if compacted. To obtain satisfactory results, the sand must be dry as well as hot. If the sand in the pit when used is fairly dry, it can be mixed in a hot mixer without preliminary heating; but this is not economical, as from 5 to 6 min. is required to mix a batch thoroughly, whereas with hot sand the mixing can be done in about 2 min. The oil, before mixing with the sand, is heated in kettles or tanks to a temperature of from 250 to 375° F., depending on its nature.

The sand-and-oil mixture is immediately carted to the road and spread, usually in one course, although under some conditions spreading in two courses may be preferable. The mixture is shaped with rakes and immediately rolled. A horse roller is used for the preliminary rolling, but the surface should be rolled with a tandem steam roller in the course of a few hours. The length of time that should elapse before using the tandem roller depends on the temperature and general weather conditions, but ordinarily any material placed in the morning can be rolled in the afternoon of the same day. During the rolling with steam roller the surface is reshaped with a road machine, which removes any inequalities developed during the preliminary rolling. The results obtained on roads not shaped with a suitable scraper during rolling have shown that this work is necessary if the best results are to be obtained on mixed sand-and-oil work. It is not advisable to use a steam roller for the preliminary rolling, as it tends to force the mixture out of shape when fresh and to produce an uneven and wavy surface.

If the grains of sand are rounded, and especially if the sizes of the grains vary little, as with ordinary beach sand, a very heavy oil asphalt gives the best results, whereas with sharp sand well graded and containing a considerable proportion of grains that will not pass a screen with ⅛-in. mesh, an oil having a viscosity of from 800 to 1,700 sec. (Lawrence viscosimeter) at 100° C. gives good results.

After the sand-and-oil mixture has been thoroughly rolled, the surface is sealed by the application of hot oil having a viscosity of from 250 to 600 sec. (Lawrence viscosimeter) at 100° C. This oil is applied at the rate of ½ gal. per sq.yd. and is spread by a pressure distributor in two ¼-gal. applications, each followed by a light covering of sand. This coat not only seals the surface of the mixed sand and oil, but also adds about ½ in. to the thickness.

A mixed sand-and-oil surface should have a crown of not over ½ in. to the foot and should be not less than 18 ft. wide, since with mixed sand and oil, even more than with a surface constructed by the layer method, the edges will be rapidly broken down if there is any considerable amount of driving from the sand-and-oil surface onto the shoulders. The thickness should be from 3½ to 4 in. before the seal coat is applied.

The cost of mixed sand-and-oil surfaces, including the seal coat, has varied from 40 to 61c. per sq.yd., the average being 52c. This cost is for the surface alone and does not include grading, culvert work, etc. The average yearly cost of maintenance for those roads which have been in use at least 5 yr. is 1.6c. per sq.yd., and for those in use 3 yr. ¾c. per sq.yd.

Traffic-Bearing Capacity of the Two Types

The amount of traffic a sand-and-oil road will safely carry is as yet somewhat problematic. It is probable that there has been no instance in this state where a sand-and-oil road of either type has failed if properly constructed of suitable material. On the other hand, the layer roads have been constructed only in those sections where the travel is comparatively light, and none of the mixed surfaces have been subjected to any very large amount of heavy traffic.

Under heavy loads the layer roads have shown some evidences of weakness, but there has been no indication of failure with the mixed surfaces. That neither road will carry a large amount of horse-drawn traffic alone is evidenced by the fact that such surfaces have in several instances been badly cut up by the passage of a troop of cavalry or a large number of transport wagons during army maneuvers.

It has also been observed that a mixed sand-and-oil surface which has carried successfully quite a heavy traffic during the summer, when the proportion of motor travel was comparatively large, has been considerably cut up in the spring before the motor-traffic season commenced, although evidently the actual number of horse-drawn vehicles was much less in the spring than during the summer.

It seems probable from the experience thus far gained with sand-and-oil roads in this state that the layer road will carry only a light traffic and is a suitable type of road only where the conditions will not warrant a more expensive surface. Aside from the amount of traffic a layer road will carry, it is probably impossible to obtain by this method as satisfactory a surface as by the mixed method. However, if the travel is light, not only can a surface be constructed at a comparatively small cost but such a surface can be economically maintained.

Activated-Sludge Experiments at Milwaukee, Wis.*

By T. Chalkley Hatton†

SYNOPSIS—Varied and extended studies of the activated-sludge process of sewage treatment conducted during the past year are summarized and conclusions drawn. The previous article, which appeared in the issue of Feb. 10, 1916, outlined the experimental plant and summarized the results obtained with different kinds of air diffusers.

II. General Results and Costs

Our experiments to determine the volume of air required for oxidation and for agitation and the volume delivered from which no useful work is secured have not been conclusive, except to show that far more energy is imparted by the volume of air supplied than is necessary for oxidization or agitation; but the air performs other useful work in the process, which cannot be performed by mechanical agitators and the exact nature of which we have not yet ascertained.

Purification may be effected by means of mechanical agitators with less air than if air agitation is used; but the time required is much greater, and the sludge is broken up into much smaller particles, is less absorbent and settles less rapidly.

From our experiments along these lines we are of the opinion that the most economic agent for agitating the liquor is air applied in such volumes as may be determined in each case to procure the degree of purification desired. This naturally brings about the statement that activated sludge accomplishes four principal functions—the clarification of the liquor, removal of the putrescible organic matter, reduction of bacteria and, finally, if the process be continued for a sufficient period, oxidization of the ammoniacal compounds into nitrates. Therefore, one of the first steps in designing a plant in which this process is to be employed is to determine the degree of purification required, following which arise questions as to efficiency, volume of air required, period of application, and volume of activated sludge necessary to be kept in retention with the raw liquor.

Statement of the Milwaukee Problem

Our problem in Milwaukee embraces the clarification of the liquor, securing an effluent that is stable for five days, the reduction of the suspended matters 90%, nd 95% removal of bacteria at 20° C. With our continuous flow tank we have secured this average effluent for months by using 1.75 cu.ft. of air per gallon of sewage with 4 hr. aëration, 20% activated sludge and from 10 to 15 min. sedimentation period. Basing these results upon the operation of a 50,000,000-gal. plant, the estimated cost will be $4.38 per 1,000,000 gal., including all overhead and boiler-room charges, but excluding engine-room and plant attendance and the cost of disposing of the sludge.

There appears to be no difference in the results obtained by carrying out the process either by the fill-and-draw or the continuous-flow method, considering volume of air applied per gallon, cost of aëration and volume of activated sludge required; but measured in terms of cost of construction and operation, the continuous flow is the superior method. With a wide variation in strength of liquor and rate of flow a more uniform standard of effluent can be obtained from the fill-and-draw method, because it is susceptible of better control, which is true of all fill-and-draw processes.

In order to maintain clarification and stability and to remove at least 95% of the bacteria from the Milwaukee sewage we have found it necessary to carry on the nitrogen cycle far enough to develop from 3 to 5 parts of nitrates. This has not been at all difficult to maintain.

Effect of Low Temperature on the Process

We have just passed through a very interesting period, the description of which fits in at this point. By reason of a shutdown for two weeks of the main sewage pumping station no sewage could be obtained for running our experimental plant. Wishing to conserve the activated sludge in our tanks, we continued to aërate it quietly throughout this period, without adding any fresh sewage. The nitrates decreased from 5 parts to about ½ part, when the station was started. Immediately the temperature of the atmosphere grew very cold, snow came, followed by two days of thaw, followed by several days of temperature from 5 to 15° below zero.

During this time the temperature of the sewage ranged from 55° F. to 42° F.; the effluent was uniformly clear, with four days' stability, 90% removal of bacteria and a reduction of nitrates from 0.7 to 0.5, there being about the same amount in the raw sewage. During this time the volume of air, rate of application, and volume of liquor treated were not changed from the cycle in which the plant was being operated prior to the shutdown.

This indicates that low temperatures are not going to affect the process as much as we had anticipated. We believe, however, that the effect of such low temperatures continuing over long periods may be easily overcome by adding more air or by a higher degree of activated sludge or by both. Thus the trouble can be overcome without excess tankage.

If more air is applied for a greater period, of course the nitrates are greatly and rapidly increased. This increases the value of the sludge. Whether this increase will pay for the additional air used is a matter yet to be determined.

Results with Various Periods of Aëration

Table 1, taken from the results obtained during a line of experiments on the fill-and-draw tank, illustrates the effect of the same rate of air applied over increasing periods.

These data clearly point to the fact that well-activated sludge coagulated the colloidal matters about as com-

*Slightly condensed from a paper read before the Illinois Section of the American Water-Works Association and the Illinois State Engineers' Society, at Urbana, Ill., Jan. 27, 1916.

†Chief Engineer, Sewerage Commission, Milwaukee, Wis.

pletely in 1 hr. as in 5 hr. In 3 hr. it had removed 92% of the bacteria and made the effluent stable for more than five days.

TABLE 1. PURIFICATION OF SEWAGE COMPARED WITH PERIOD OF AERATION

Aeration, hr.	0	1	2	3	4	5
Cu. ft. of air per min.	0	160	160	160	160	160
Cu. ft. of air per gal.	0	0.67	1.32	1.98	2.64	3.31
Appearance of settled liquor	Turbid	Clear	Clear	Clear	Clear	Clear
Stability, hr.	0	2	33	120+	120+	120+
Bacteria removed, %	0	52	81+	92+	95+	98+
Free Ammonia, parts per million	22.00	17.00	15.00	11.00	7.00	5.00
Nitrate, parts per million	0.08	0.00	0.95	1.75	2.20	2.50
Nitrate, parts per million	0.08	0.04	0.70	2.80	5.60	8.20
Dissolved oxygen, parts per million	0.00	0.30	1.90	4.30	5.90	6.70

The most economical ratio between diffusing surface and tank surface has not been definitely determined. Our ratios run from 1 to 5 to 1 to 8.5. There appears to be no appreciable difference in the results obtained. We are inclined to the belief, however, that a much greater ratio would reduce the efficiency by permitting more air to escape without giving the liquor the maximum opportunity to absorb it.

While all of our experiments have been made upon tanks holding 8 to 10 ft. of liquor, our supplementary experiments indicate that more efficiency of air can be obtained in deeper tanks by reason of the longer contact period between the air and the liquor and the tendency of the air, as it escapes from the diffuser, to break up into smaller bubbles because the pressure head upon it has been increased. Local conditions might, and probably would, largely control the depth of tank.

It appears to be true that the greater pressure for which a blower is built (considering the larger units) the greater its efficiency; that is, a blower which will deliver the air at 10 lb. pressure is more efficient than one which will deliver the same volume of air at 5 lb. pressure.

Volume of Applied Air Important Factor

The purification of sewage obtained varies decidedly with the volume of air applied. Small volumes applied for 5 or 6 hr. do as well as larger volumes applied for 3 or 4 hr.; but the time of aëration required to obtain a like effluent does not vary directly with the volume of air applied per unit of time. For instance, air applied at a rate of 2 cu.ft. per min. purifies the sewage in less time than 1 cu.ft. of air per minute, but will not accomplish an equal degree of purification in one-half the time.

There is also a limit to the volume of air applied per period of application, below which it is not possible to secure any significant degree of purification. If less than 1 cu.ft. of air per gallon of sewage treated be applied for a period of 4 hr., the degree of purification of the Milwaukee sewage rapidly decreases until little or none is effected; but if the period of application is continued long enough, this rate of air will produce any degree of purification required.

TABLE 2. RELATION BETWEEN THE VOLUME OF AIR APPLIED AND PURIFICATION IN THE CONTINUOUS-FLOW TANK

Average No. of Cu. ft. of Air applied per Gal.	Gal. Treated per Day	Stability Hr.	% Bacteria Removed	Nitrogen as: Free Ammonia Parts per Million	Nitrate Parts per Million	Organic Nitrogen, Parts per Million	Suspended Matter, Parts per Million
1.80	62,000	120	98	1.95	8.5	4	11
1.53	65,000	120	99	5.79	9.0	8	9
1.12	65,000	73	91	10.10	2.3	14	42

Table 2 shows that air applied for 5 hr. at the rate of 1.53 cu.ft. per gal. purified the sewage very well; but when applied at a rate of about 1 ft., the stability fell off very materially.

In view of the fact that the air is the most important item of cost in the operation of the activated-sludge process we tried out many experiments with the purpose of determining the effect of decreasing the period of aëration and rate of application. It was evident that by reducing the volume of air the efficiency of the process was decreased. When the period of aëration dropped to 2½ hr., although the air feed was increased proportionately, nitrates were formed in such small quantities that the settled liquors putrefied in about four days.

Land Area and Construction Costs per 1,000,000 Gal.

Our experiments so far indicate that, with rectangular tanks 15 ft. deep, 15,000,000 gal. of sewage can be treated per acre of ground covered, including influent and effluent conduits, sedimentation and sludge tanks, and that the cost of such tanks, including influent and effluent conduits, pipe foundations and all piping, will be approximately $18,000 per 1,000,000 gal. This cost is based upon our local conditions, where the tanks have to be built out into the lake and supported upon piles.

The sedimentation period required to reduce the suspended solids to 10 or 12 parts per million is from 10 to 25 min. The latter seems to be a maximum with low temperatures.

We speak of maintaining a certain percentage of activated sludge with the sewage during aëration. In order to establish an easily determined unit we have fixed on that volume settling during ½ hr. It is true that this is an arbitrary determination, but it is logical nevertheless. From a great many tests it has been found that 78% of well-activated sludge will settle out of the mixture in ½ hr. and that during the next ½ hr. the addition is but 4%. It is desirable, in operating a plant, to determine frequently the volume of this sludge in contact with the liquor. One hour is often too late to get the most benefit from any change demanded. This sludge, so settled out, has about 98% moisture content, and it is desirable to return this sludge to the raw sewage with as little water content as practicable, because the more water the more tank area required.

To get this result, it is necessary, not only to let the sludge settle for at least ½ hr., but also to put it under a pressure from a head of water over it. In our new tanks we let the sludge from the sedimentation tank settle to the bottom of a 4-ft. chamber built under the tank and 35 ft. deep, whence it is pumped out after being compacted by a head due to 34 ft. of the liquor over it. Then it is further aërated in reservation sludge tanks, again settled, and pumped from the bottom of the second sludge-settling tank to the raw sewage.

From our experiments we find that under a 26-ft. head of liquor the sludge will be dewatered in ½ hr. from 98% to 94% and lose 40% of its volume. If a 94% rich activated sludge can be mixed with the raw sewage as it enters the aërating tanks, the size of these tanks can be materially reduced. By extra aërating the sludge to be returned to the raw sewage it is believed that the volume of air required to treat raw sewage will be diminished. Thus the cost will be decreased, because it will require only one-fifth of the volume of air to give this sludge the extra aëration (providing 20% of activated sludge is being maintained in the sewage

tanks) that is required to give the whole body of sewage treated the same air treatment. It has been demonstrated beyond doubt that the richer the activated sludge in nitrates the quicker the purification of the sewage, and the less air required.

The sludge produced is quite brown in color, appears like pieces of finely divided sponge and settles out of the quiet liquor very rapidly—65% will settle in 10 min. It is readily drained on the ordinary sludge-drying beds, requiring about one-half as much time as does well-digested Imhoff sludge, but it acts differently. During the first hour the liquid drains through the bottom. The sludge, gradually settling upon the surface, seems to close the interstices of the bed; the liquid rises to the top of the sludge, from which it can be titrated without disturbing the settled sludge. With two days of dry, warm weather its moisture content will be reduced on drying beds from 98% to 82%, and in two weeks the moisture will be reduced to 65%.

The sludge seems to absorb the colloidal matter very rapidly. Highly colored liquor introduced into it will be decolored in a few minutes. It has no apparent odor. When well activated, the sludge produced by the Milwaukee sewage contains from 14,000,000 to 18,000,000 bacteria per c.c., from 5 to 6% of fats and 4.4 to 9% of total nitrogen (NH_3), based upon 10% moisture. At the present market the value of this sludge, when degreased and reduced to fertilizer—that is, dried to 10% moisture and ground—ranges from $10 to $20 per short ton.

The Milwaukee sewage produces on an average about 3,000 gal. of sludge per 1,000,000 gal. at 98% moisture. On the basis of 10% moisture it produces about ½ ton per 1,000,000 gal.

The cost of dewatering, degreasing and drying the sludge has not yet been definitely determined, but from a careful study of this question it is believed that this cost will not exceed $6 per dry ton. Apparatus for performing this portion of the work has already been arranged for and will be installed in our new 2,000,000-gal. plant during February, 1916.

We feel sufficient confidence in the process to have recommended it for adoption by the City of Milwaukee and have suggested a 100,000,000-gal. plant, the designs of which are already in course of preparation.

It has been frequently stated in public print that the process is so delicate in its operation that only by the exercise of the most careful supervision can satisfactory results be secured. We believe this to be an error, as we have found no conditions arising which would lead us to such a conclusion; and if one realizes the simplicity of the process, he will certainly agree with us.

Assuming the plant is properly designed and built, there are only two main factors to be considered in successfully operating it, and these can be determined by a careful and skilled workman. Proper volume of air and activated sludge are these two factors. The character of the effluent is very well shown by two things—turbidity and suspended matter. Both can be determined in a test tube by observation. Volume of activated sludge can be determined in ½ hr. by the same means. The quality of the sludge can be judged by its color, after the observer has had some experience.

If the character of the effluent, as measured by turbidity and suspended solids, is not satisfactory, the first step is to find out the percentage and color of the sludge. If this has been reduced, two valves must be opened a little wider—the air valve to the sludge-aërating tank and the sludge valve controlling the sludge feed to the raw sewage. If this fails to get the results, the air valve feeding the aërating tanks is to be opened wider. Under ordinary conditions the last step would be the first, because it will immediately rectify the trouble temporarily until the sludge determinations are made.

Stresses in Rivets Used in Direct Tension

By Jacob M. Friedland*

In the discussion of the use of rivets in direct tension that was recently called out by the letter of Ernest McCullough in *Engineering News* of June 10, 1915, it appeared that current good practice is against such use. Edward Godfrey, however, seems to be of the opinion that for this antagonism there is no good theoretical basis, since, according to him, "a little analysis will show that pulling on the head of a rivet already in stress due to shrinkage does not increase the stress on the rivet but relieves the pressure on the plates, unless the added tension exceeds that already in the rivet."

If the above statement were true, there would indeed seem to be no reason against applying dead-load or moderate live-loads up to the temperature stress in the

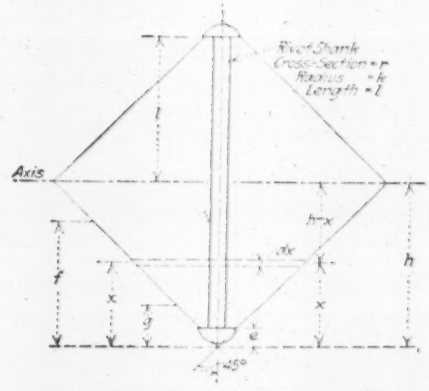


DIAGRAM SHOWING RIVET IN TENSION

rivet, for the mere fact that the rivet has not ruptured after driving shows that it is capable of sustaining at least such a load.

But while a *little* analysis may show what Mr. Godfrey says it shows, the study given below produces quite different results.

The accompanying drawing shows a rivet between whose heads is metal (plates, angles) having a total thickness $2\,l$. This metal fits snugly around the rivet shank and is under initial compression due to the shrinkage of the rivet on cooling. The "axis" is a line drawn midway between the rivet heads, and loads, stresses, etc., above the axis are the same as below it.

For the purpose of the following analysis it has been considered sufficient to assume that the volume of stressed metal consists of two truncated cones base to base (on the axis) with an angle of 90° at the apex, the rivet hole

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being deducted from the area, and that within this volume the compression stresses are uniformly distributed over each horizontal layer, decreasing in intensity as the layer increases. The minimum area, under the rivet head, is equal to the under side of the rivet head.

A load p is attached to the layer located x inches above the apex of the lower cone. Part of p, say w, will compress the metal $x - e$ below the layer, and reacting against the rivet head, will stretch the rivet shank; while the remainder $p - w$ will stretch the metal $h - x$ above the layer. The elastic deformation is such that the stretch in the rivet plus the compression in the metal below p must equal the stretch in the metal above p. If s is the area of any horizontal layer of metal, dx its thickness, E the coefficient of elasticity of steel, r the cross-section of the upset rivet shank, the above equality is given by the formula

$$(p-w)\int_x^h \frac{dx}{Es} = w\int_e^x \frac{dx}{Es} + \frac{wl}{Er}$$

from which we get the fraction of the load p that goes to increase the initial rivet stress

$$\frac{w}{p} = \frac{\int_x^h \frac{dx}{s}}{\int_e^h \frac{dx}{s} + \frac{l}{r}} \qquad (1)$$

that is, the load transmitted to the rivet is to the load suspended as the extensibility or "give" in the metal from the axis down to the load is to the extensibility or "give" in the whole system, rivet shank included.

If a depth of metal between $x = g$ and $x = f$, having a thickness $f-g$, is continuously loaded with a total load P, the intensity per inch depth is $\frac{P}{f-g}$, and p in formula (1) becomes $\frac{P}{f-g}\,dx$. The fraction of the total load P transmitted to the rivet is then given by

$$\frac{\int_g^f w\,dx}{P} = \frac{1}{f-g}\int_g^f \frac{\int_x^h \frac{dx}{s}}{\int_e^h \frac{dx}{s} + \frac{l}{r}}\,dx \qquad (2)$$

If k is the radius of the upset rivet shank, $s = \pi(x^2 - k^2)$, and (2) becomes

$$\frac{w}{p} = \frac{\int_x^h \frac{dx}{\pi(x^2-k^2)}}{\int_e^h \frac{dx}{\pi(x^2-k^2)} + \frac{l}{r}}$$

$$= \frac{\frac{1}{2\pi k}\left(\log\frac{h-k}{h+k} - \log\frac{x-k}{x+k}\right)}{\frac{1}{2\pi k}\left(\log\frac{h-k}{h+k} - \log\frac{e-k}{e+k}\right) + \frac{l}{r}} = \frac{N}{D} \qquad (3)$$

which when integrated gives the formidable-looking but perfectly docile expression

$$\frac{\int_g^f w\,dx}{P} = \frac{1}{f-g}\,\frac{\frac{1}{2\pi k}\{(f-g)\log\frac{h-k}{h+k} - (f-k)\log\frac{(f-k)}{(g-k)} + (f+k)\log\frac{(f+k)}{(g+k)} - (g+k)\log\frac{(g-k)}{(g+k)}\}}{D} \qquad (4)$$

The logs are Naperian logs, that is, common logs multiplied by 2.3. The application of the formula gives the following percentages of the suspended load that tend to increase the initial tensile stresses in the rivet:

Two ⅜-in. angles back to back, held by a ⅞-in. rivet, 13%.

Two ½-in. angles back to back, held by a ⅞-in. rivet, 11.3%.

Two ⅝-in. angles back to back, held by a ⅞-in. rivet, 9.9%.

Two ⅝-in. angles with two ½-in. plates between, the load suspended from the lower angle, 10.08%.

Two ⅝-in. angles with two ½-in. plates outside the angles acting as fillers under the rivet heads, 2.59%.

Two ⅝-in. angles with 4¾ in. of plate between, giving a total thickness of 6 in., 6.33%.

Two ½-in. angles with one ½-in. plate between (beam-connection angles on each side of a ½-in. web), 12.1%.

The use of ¾-in. rivets gives slightly smaller percentages.

The numerator of formula (1) shows that for a given thickness of metal the farther the metal carrying the load is from the rivet head the smaller is the percentage of the transmitted stress. Formulas (3) and (4) and the computed results show that the thicker the metal between the rivet heads, and the thinner the rivet, the greater is the extensibility of the whole system, and therefore the smaller is the percentage of the load transmitted to the rivet. But until more is known about the way in which an increase in the thickness of the metal affects the initial rivet stress, these deductions warrant neither the arbitrary thickening of the metal nor the insertion of fillers for the purpose of keeping the load-carrying metal away from the rivet heads. In fact computations based upon the assumption that the *initial* rivet stress is distributed in the plates in the same way as the *direct-load* stress seem to indicate that up to 6 in., at least, the initial stress increases faster with an increase in thickness of gripped plate than the transmitted direct load decreases.

If a load of 8,000 lb. per sq.in. of rivet metal, or 4,800 lb. per ⅞-in. rivet, is applied in direct tension, 13% of this adds only 1,040 lb. per sq.in., or 625 lb. per rivet, to the initial rivet stress. For short rivets, which are easier to drive properly than long rivets, this additional load will not cause rupture, even if we consider the necessarily eccentric application of the load through flexible angles. Where the direct pull is very great, for example, the pull on the rivet heads of connecting angles, produced by end moments in beams framed into girders, which according to computation at least, may exceed 16,000 lb. per ¾-in. rivet, an addition of 12%, or 4,340 lb. per sq.in., may rupture even a properly driven rivet.

The above analysis shows, on the one hand, why many direct-tension details do not fail; and on the other hand, where their weakness lies, and the limitations under which it may be safe to design such details. If rules are justified by theoretical analysis without substantiating tests, the following seem to be warranted:

1. For rivets easy to drive properly, a load of 6,000 lb. to 8,000 lb. per sq.in. may be allowed if the rivet acts in tension only and is not subject to shear, in fact (not on assumption).

2. The precautions prescribed by Mr. Godfrey should be observed.

3. The inherent weakness of rivets is that they often have an initial stress above what would be permitted in safe steel design. As a direct tensile load always adds to the initial stress, one is forced to the conclusion that details involving direct tension on rivets should be avoided.

Flood Control in Los Angeles County in California--II

SYNOPSIS—The serious flood damages in Los Angeles County, Calif., due to the steep mountains on which heavy rainfall occurs in winter discharging sudden floods upon the plains, were explained in the preceding article. The present article summarizes the methods of preventing flood damage recommended by the Board of Engineers appointed to study the problem.

In southern California the débris cones have no little effect on the problem of flood prevention. Wherever the torrents from these steep mountains debouch upon the plains, they have built up in the course of past ages a fan-shaped deposit of sand, gravel and boulders, often hundreds of feet in depth. While débris cones are more or less familiar to engineers as a feature of topography, they assume great importance in this southern California region, where the geological structure of the country is so recent that the process of mountain erosion and valley deposits can be watched at the present time.

The amount of solid matter carried down by these mountain streams when in flood is almost incredibly great. The heaviest material—boulders, cobblestones, etc.—is deposited in the lower reaches of the torrent, where the velocity lessens, or immediately at the mouth of the cañon. Gravel and coarse sand are deposited all along the débris cone, wherever the stream velocity slackens. Finer material is carried in suspension for miles down the stream and even to the ocean 30 mi. away.

It is estimated that 365,000 cu.yd. of material was deposited in Los Angeles harbor by the flood of 1911. The deposit in the dredged areas of Los Angeles harbor during the flood of 1914 is estimated at 2,600,000 cu.yd. and in the adjacent Long Beach harbor at 700,000 cu.yd. Including material deposited in areas that have not yet been dredged, it is estimated that fully 4,000,000 cu.yd. was deposited in these harbors as a result of the 1914 floods.

FIG. 1. FLOOD IN LOS ANGELES RIVER BELOW CERRITOS BRIDGE. PACIFIC ELECTRIC RY., JAN. 18, 1916

The view shows the break in the levee erected by the city to confine the river to its own channel. The waters flowing through the bridge in this levee are cutting across the Dominguez Ranch and into Dominguez Creek and rapidly eroding a new channel

Of this fine material carried into the ocean, however, only a small part comes from the mountain slopes. The rivers left their old channels and spread over the rich plains near the ocean, and the report says: "These flood waters rushing over the rich arable land between Wilmington and Long Beach, which was practically all under cultivation, eroded therefrom immense quantities of valuable soil."

Regulating Streams Without Channels

In order to understand the difficult problem of flood control in this section it should be understood that these huge floods are discharged onto plains which have in many cases no well-defined channel for their discharge. The mountain torrent brings its huge burden of débris down to the mouth of the cañon, chokes the channel below with it and then spreads out on each side. What is true of this immediate point is true lower down. The stream bed is being continually built up above the surrounding country as the flood slackens and the stream velocity grows less. The tendency to channel choking is aggravated by the rapid growth of willows and other vegetation in the bed of the stream. In this climate such vegetation, fed by the underflow of the stream, very quickly chokes and restricts the channel and increases the deposit of débris. Thus nature left to itself is continually blocking up the old channels of the rivers and opening new ones.

FIG. 2. DAMAGE DONE BY LOS ANGELES RIVER FLOOD AT LONG BEACH, CALIF., JAN. 18, 1916

The plains upon which these mountain torrents discharge contain some of the most valuable agricultural lands in the United States. The citrus groves, fruit farms and truck farms on these plains, worth thousands of dollars an acre, may be a long distance from any of the old stream channels made by the floods of former years and yet be liable to be overwhelmed when the next flood comes.

Moreover, the flood in this section does not merely inundate the land with water. This, with the damage or destruction of buildings and improvements, would be

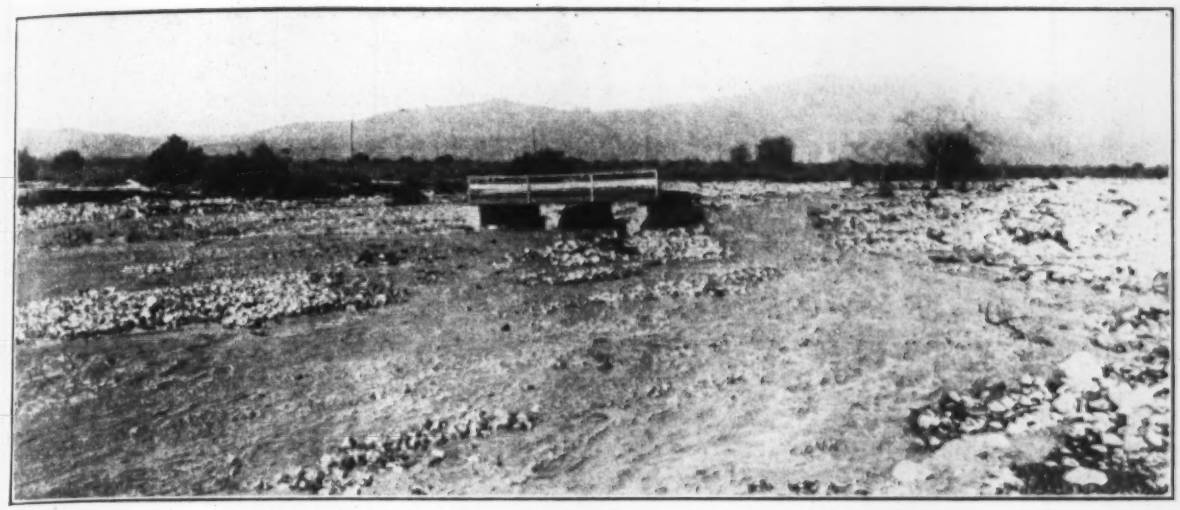


FIG. 3. SAN ANTONIO CREEK SPREADING OVER ITS DEBRIS CONE

bad enough; but what happens when one of these southern California floods starts in a new direction is, first, excavation of a new channel, tearing out and carrying away the fertile top soil, and, later, as the flood subsides, filling in this channel with a deep deposit of barren sand and gravel.

Besides the valuable agricultural lands that are threatened by these floods, the entire district around Los Angeles contains essentially suburban territory for a long distance. The damage done to buildings, bridges, roads and other city and village property in the great flood of two years ago was enormous in amount. As can be seen from the situation just described, it is not a matter merely of risking the loss of buildings and land near the old stream channels. The uncertain path of the floods brings the homes of a very large population within the danger zone.

Possible Methods of Flood Prevention

A great deal has been printed within the last few years on the relation of forests to floods. There still remains a widespread popular belief that, if a region is covered with a heavy forest growth, floods from it will not occur. The fallacy of this idea is well illustrated by the situation in Los Angeles County. The mountains from which these destructive floods come are for the most part clothed with a heavy growth of shrubbery native to the locality. The long dry season when practically no rainfall occurs, from the middle of April to the middle of October, makes impossible any larger forest growth on these mountains; but even if it were possible to produce it, there is no reason to believe that it would more effectively protect these steep mountain slopes from wash than does the shrubbery now growing there; and it might not give as much protection.

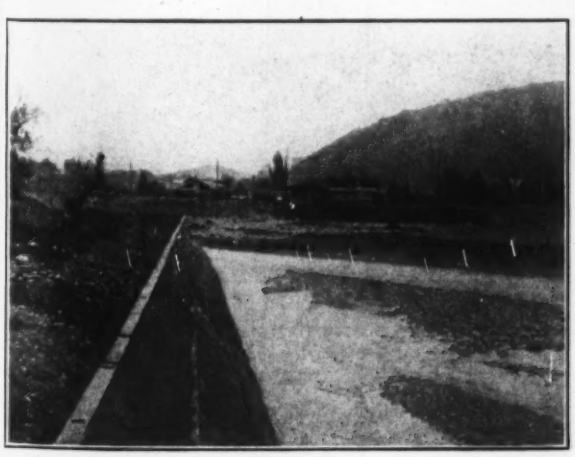


FIG. 4 CHANNEL OF ARROYO SECO IN LOS ANGELES PROTECTED BY MASONRY WALL

It is true that fire has swept over some small portions of the mountains and burned off the shrubbery. From these areas the wash of solid matter is much heavier in time of severe rains, and the commission recommends that a moderate amount be spent in planting brush growth on these now barren areas. It is clearly understood, however, that no possible forest cover on these steep mountain slopes will prevent some soil wash from them in time of heavy rain.

The storage of flood waters in great reservoirs has been thoroughly discussed in engineering literature. The two great obstacles to its adoption in Los Angeles County are the lack of suitable reservoir sites and the fact that the great amount of solid matter carried by the stream would very quickly fill a storage reservoir full, if it were built. The commission nevertheless has examined two or three possible sites for storage reservoirs and considers their use possible in connection with other measures hereafter to be described.

The Plans Recommended

The foregoing brief review will give the reader some idea of the unusual difficulties, never presented elsewhere in the United States in connection with the question of flood control. If the region affected were in the same condition as 25 years ago, the problem might well be given up as unsolvable from the financial point of view. The great increase in population, wealth and land values in the territory affected, however, and the serious threat to the safety of life and property which the floods constitute make an engineering solution imperative.

It will be evident from the review herewith that the difficulty in the flood-control problem in Los Angeles County arises not so much from the great volume of

water to be handled as from the enormous amount of solid matter, boulders, gravel, sand and silt brought down by the floods. To retain this solid matter, or a great part of it, in the mountains and prevent its discharge upon the plain is therefore one of the first essentials in solving the flood-control problem. The commission hopes to effect this by going direct to the flood sources and there building rough check dams on the mountain torrents. By these check dams it is hoped so to reduce the velocity of the torrents as to prevent most of the boulders and gravel, at least, from being carried down with the water. In a following article Mr. Frank H. Olmsted, of the commission, describes the check dams which have already been built as an experiment for the control of mountain torrents and which are to be largely extended.

FIG. 5. A CONCRETE BRIDGE ON THE NEW STATE HIGHWAY AT CROSSING OF SAN ANTONIO CREEK

Storing Flood Waters Underground

Reference was made above to the débris cones, enormous deposits of gravel and sand that have been built up wherever a stream from the mountains issues upon the plain. In the interstices of these vast gravel beds is stored the water from which the supply is drawn to irrigate the great bulk of the fertile lands lying between the mountains and the sea. Were the rainfall uniform throughout the year and the flow of the streams of the mountains fairly constant, there is little doubt that the entire runoff from the mountain section would be swallowed up by the river bed and spread out as an underflow over all this vast porous plain, and little or none would ever reach the ocean as a visible flow in the channels of the rivers.

The material in the débris cones has been sorted in the process by which they have been built up. Near the mountains one finds coarse gravel, cobbles and boulders extending to great depths. Farther away the material is fine gravels and sand. Beyond the present visible débris cones, toward the ocean, the deposits change to the finer sands and silt.

It will be evident that water flows underground more readily in the coarse deposits near the mountains than in the finer deposits found on the plains. These fine deposits, in fact, act like a dam to obstruct the flow of the underground waters toward the sea and thus conserve the supply for the use of irrigators, who pump it from wells. Further, the greater the amount of water that can be poured into these débris cones at their highest points, next the mountains, the greater will be the available underground supply for the wells of the ranches farther down the plain.

The flood commission favors, therefore, measures to divert as much as possible of the flood flow into these underground reservoirs. All the water that can be thus disposed of will be so much less to take care of in the lower courses of the stream and will be so much added to the available store on which the irrigators may draw.

Precedent exists, fortunately, for this diversion underground of flood waters. In San Bernardino County a large amount of work has been done in the past few years in spreading the river flow upon the débris cones. Experience there has shown that flood waters can be diverted underground at a cost of approximately 14c. per acre-foot, including both operating and interest charges. This is less than 5% of the value of the water for irrigation purposes. To secure the best results, however, the channels in which the water is spread on the débris cones should be kept free from the muddy water discharged in time of flood, as this rapidly clogs the infiltration channels to the detriment of the flow.

FIG. 6. GRAVEL PIT 30 FT. DEEP ON PACIFIC ELECTRIC RY. FILLED FULL BY SAN ANTONIO CREEK

Note that a channel has been cut across the main-line track

FIG. 7. SANTA FE RY. BRIDGE ACROSS SAN ANTONIO CREEK NEAR LOS ANGELES

Part of spans blocked by débris and dangerous scour around others

After all has been done that can be done in protecting the mountain slopes from erosion, in checking the rate of flow of the mountain torrents by check dams, brush dams, etc., to delay the progress of the floods and especially to prevent the carrying down of boulders and gravel to clog the channels across the plains below, and after as much has been done as can be done to divert the waters into the underground reservoirs formed by the débris cones, there will still remain a great volume of flood water to be discharged down the old stream channels.

To enable these channels to carry this flow, a large amount of work will be required in clearing the channels from débris and willow growth and in protecting their banks, by training walls of various sorts, from erosion and overtopping. A great many different types of structure are recommended, according to the local conditions.

Estimate of Cost

The total estimated cost of the entire works recommended by the board for flood prevention is $16,509,000. Of this estimate a little less than $13,000,000 is for structures, and about $3,700,000 is for rights-of-way and land damages. In the estimate of cost of physical structures an addition of 30% has been made to the field cost, to cover such overhead charges as engineering, legal and general expenses, workmen's compensation insurance (a heavy item under California law) and provision for minor waterways not specifically mentioned.

The total estimated cost of the impeding dams, contour furrows, etc., to be built to control the mountain torrents is about $1,700,000. The works for spreading the water on the débris cones are estimated to cost about $1,500,000. For clearing and leveeing the channels of the streams through the San Fernando and San Gabriel district the estimated cost is over $7,000,000, including the rights-of-way; and for the channels across the plain leading to the ocean, about $5,500,000. It is estimated that at least five years' time will be required for the construction of the works recommended.

The Floods of 1916

Since this article and the one preceding it were prepared for publication, Los Angeles County has suffered two severe floods. While the damage was not nearly as great as in the flood of 1914, it was of large amount as may be judged from the accompanying views.

The first flood reached its maximum stage on Jan. 17, 1916, and carried away more than a score of bridges in Los Angeles County, many of them of considerable size. The approaches to many other bridges were washed out so as to render them impassable, and much damage was done to railway roadbeds and highways; the network of interurban electric railways was tied up, and trains were discontinued on most of the steam railways. Several lives were lost in the floods, most of them in the mountain cañons. In the lower lands many families were rescued from their homes in boats.

The damage done by this flood was sufficiently repaired so that train service was just resumed when there came a second severe storm on Jan. 27, the same which wrought such serious damage in San Diego County; and the railway lines were again put out of business.

The rainfall in the Los Angeles River and Hondo drainage basins was much less than in the great storm of February, 1914, and the flood damages on these streams were small compared with the destruction in that year. In the flood of 1914 the Arroyo Seco, a tributary of the Los Angeles River, destroyed a number of houses and half a city park. Since that storm the city has built a heavy wall along this stream and the damage done by it this year was trifling.

In the southern part of Los Angeles County, however, the flood situation was worse than in 1914. The high mountains in this section were covered with snow from an earlier storm. The heavy rainfall melted this snow and the San Gabriel River was higher than in 1914. Similar conditions existed in San Antonio Creek and the Santa Ana River. On the latter stream three steel bridges and one wooden bridge were destroyed.

The accompanying views show something of the destruction wrought by the recent flood and particularly the extent to which the floods spread boulders, gravel and débris over a wide area. Some of the photographs show the channels across the débris cone. The débris cone of San Antonio Creek, for example, extends from Pomona to Ontario, a distance of about 6 mi. The various channels which the stream has formed across the cone are known as "washes." A correspondent informs us that even after the flood had subsided to comparatively small proportions one could distinctly hear the boulders rolling down these channels from a distance of 300 ft.

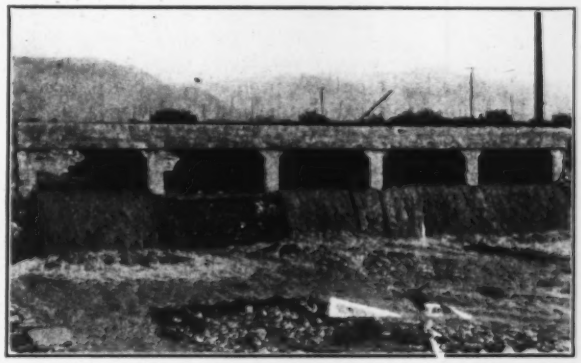


FIG. 8. FLOODS PASSING RAILWAY BRIDGE
Showing effect of paving stream bed between piers and erosion on lower side

A good illustration of the flood damage where the streams enter the ocean is furnished by the Santa Ana River, which empties into an arm of Newport Bay. A year ago the channel of the river was dredged from Santa Ana to its mouth and the banks were diked with the material excavated. During the flood the river broke over these dikes, flowed through the streets of Anaheim, flooded a great area of flat land, overtopped the line of sand dunes lying between it and the ocean, and washed out a channel over 1,000 ft. wide through the dunes, carrying with it the track and poles of the Pacific Electric Ry.

In view of the great damage done by this year's floods there can be little doubt that the plans of the Los Angeles Flood Commission's engineers will receive a public attention that might not otherwise have been given them and prompt action may be looked for to carry these plans into effect. The Board of Supervisors of the county in September last approved a general policy of flood control and an initial bond issue of $6,000,000 to begin the work. A flood-control district, with authority to make bond issues, was created by the last legislature and actual work on construction is likely to go forward soon.

Control of Mountain Torrents by Check Dams*

By Frank H. Olmsted†

The flood damage already sustained in Los Angeles County is small compared with what the coming years promise, unless a wise policy of control is energetically pursued from this time on.

The mountain area of Los Angeles County, which discharges its water onto the plains lying between the mountains and the sea, has an area of 615 sq.mi. The average elevation of this mountain district is 3,680 ft., and the average annual precipitation is between 29 and 30 in. The rainfall over this mountain area during the four days' flood period of February, 1914, averaged 14 in.

It is well known that no favorable sites exist for storing flood flow in large reservoirs in Los Angeles County. There are two available sites for small reservoirs, one holding 2,600 acre-ft., the other 4,900 acre-ft. When the cost per acre-foot of water stored exceeds $10, the proposition is not commercially attractive. The cost of water storage in small reservoir sites available in the San Gabriel Mountains averages considerably more than this.

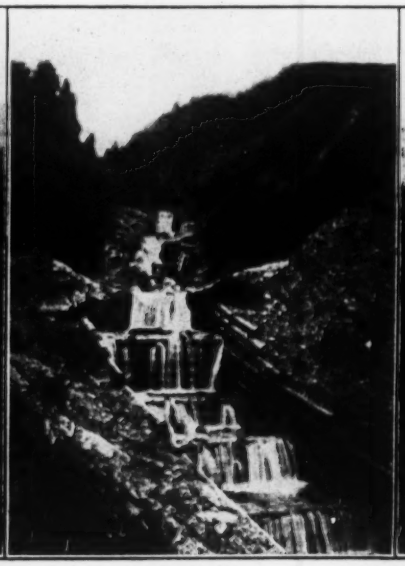
If relief from the flood conditions in Los Angeles County had to come from surface reservoir storage alone, that portion of the county subject to overflow would be doomed. Nor is the outlook promising if the protective work is confined to flood channels in the lower lands, for the detritus carried by the streams creates in the lower rivers conditions that no construction whatever will permanently retain.

The spreading of the flood flows on the gravel cones below the cañon mouth, while important to conserve the water-supply, does not promise any great relief from the maximum flood flows. If, however, we can attack these great floods at their sources in the high mountains and utilize to the greatest extent practicable the benefits of surface storage, flood spreading, channel rectification and control, we will be able permanently to relieve the people of Los Angeles County from the menace of future floods.

The writer was authorized by the County Board of Supervisors to conduct experimental work in Haines Cañon on the effect of check dams in restricting the flow of the stream and checking erosion. Haines Cañon is a tributary of the Tujunga, the drainage area of which includes 3.9 sq.mi. of mountainside that has been entirely denuded of brush and timber from a forest fire in September, 1913. The flood discharge in February, 1914, was 712 cu.ft. per sec. per sq.mi., a higher rate than that of any other stream in the county. Under the writer's supervision there have been constructed in Haines Cañon 384 small checks for retarding the velocity of stream flow. Some of these are structures of size, costing in one case $500, but in many cases costing not over $5. The total outlay was $1,650 for construction of the dams, or an average of $12.11 each, with $1,350 additional for measurements, maintenance, etc.

In Western Empire Cañon, a small tributary of Haines Cañon, with a drainage area of 22 acres, four small check dams were built before the heavy rains of 1914-15. On Jan. 28 to 30, 1915, the rainfall totaled 9.85 in. at a rain-gaging station lower down on the stream and out of the mountains. The precipitation at times reached a rate of 1 in. per hr. It is probable that in the area draining to Western Empire Cañon the precipitation was not less than 12 or 14 in. for the full storm. The four check dams referred to, however, so retarded the flow from this cañon that no flow whatever reached the main drainage line of Haines Cañon. Further, the absorption of the flow by the porous material underlying the bed of the stream has been such that this bed is now rapidly growing up with willow and brush growth where previously there was no growth whatever. This Western Empire Cañon has a grade of 23%. The writer estimates that the construction of the four 6½-ft. dams has obstructed the progress of the water down the valley enough to alter substantially the water flow to a grade of 5.2%.

STONE CHECK DAMS AND TRAINING WALLS ON THE LUNGRO



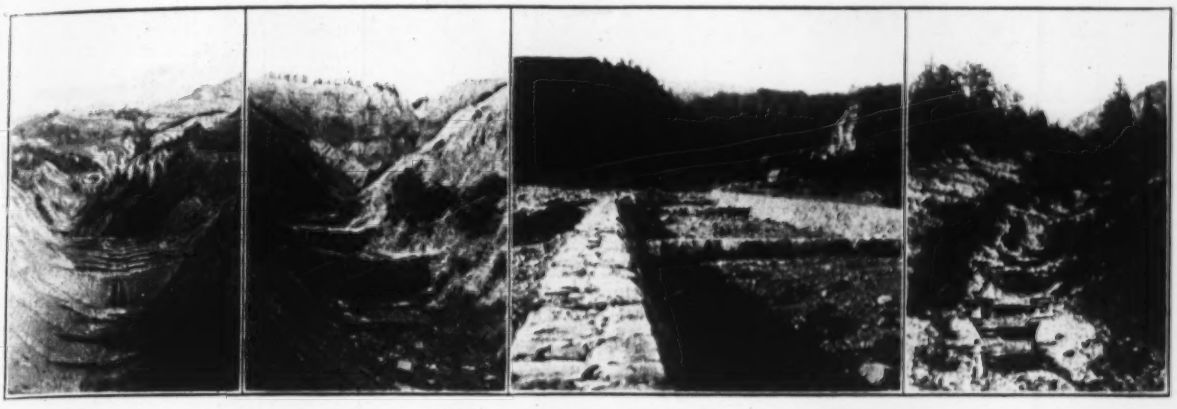
LOG DAMS AND TRAINING WALLS IN SOUTHERN AUSTRIA

DAM BUILT OF DRY RUBBLE NEAR REICHENAU, AUSTRIA

*Extracts from a report prepared by Mr. Olmsted, as a member of the Los Angeles Flood Commission, on flood control in the mountain district of Los Angeles County.

†Consulting Engineer, Hollingsworth Building, Los Angeles, Calif.

The Federal Forestry Department has furnished the writer with information concerning work of this character that has been done in Europe and gives assurance that the work planned for Los Angeles County is along safe lines. The Austrian Government has 813 streams with which it is contending and upon which it has expended millions of dollars. The greater part of these appropriations has been expended on the very headwaters of the streams in the high mountains.



VARIOUS EXAMPLES OF CHECK DAMS ON EUROPEAN MOUNTAIN TORRENTS

Japan has expended $82,500,000 on flood control in checking the velocity of 20 streams in high mountains and 45 other streams to be controlled later.

The Landquart and Nolla, Swiss streams having watersheds of 250 sq.mi. and 72 sq.mi. respectively, in mountains about as high as our San Gabriel, furnish a historic parallel to our storm-protection problem here. Efforts have been made since 1705 to prevent flood damage in the Landquart in Switzerland, and the story of two centuries of almost wasted effort by small communities to combat the flood successfully is pathetic. Their effective work commenced in 1870, when the diking of the lower river was supplemented by the damming of the Landquart, the Nolla and the débris-carrying torrents of the high mountains. The Nolla has now over 20 main dams, of dry masonry, and 46 smaller dams.

The City of Zurich, Switzerland, owns a mountain forest called the Sihwold, and in this, as in other Swiss forests, absolute control of the streams is required before expenditure for forest improvements. Stream control in the Sihwold may be classified under three heads: First, the protection of the channels of small brooks by log dams and slab facings; second, log barrages along the upper courses of medium streams and the protection of the banks by log cribs (these barrages, aside from preventing the cutting action of the stream, form pools in which the speed of the water is checked); third, a series of masonry dams reinforced by concrete retaining walls.

The advantage of extracting 15 or 20% of a flood crest before it reaches the districts where damages occur is evident, but in practically applying this method in such streams as the San Gabriel it will be seen at once how difficult and dangerous this is. To be effective as a flood-protection factor, it must deal with the maximum that comes at the cañon mouth, and the diversions must be made when the velocities are perhaps over 15 ft. per sec. The adjacent lands over which flooding occurs are lower than the stream bed itself, and on account of this there is danger if control of the situation is lost. In addition to this the flood peaks are charged with maximum quantities of silt and débris, and the spreading areas under these conditions soon become clogged up and lose their absorptive power to a large degree. Under favorable conditions an acre of area on the boulder grounds will absorb 2 cu.ft. of water per second continuously. After silting, however, it will not absorb over 1 cu.ft.

As a conservation measure primarily and as an adjunct to flood protection, the following streams are recommended by the writer for treatment by this system:

Name of Stream	Quantity of Water To Be Absorbed, Cu.Ft. per Sec.	Estimated Cost of Land	Estimated Cost of Works
San Gabriel	4,215	$320,000	$487,000
Tujunga	4,000	.....	500,000
Tacoima	3,750	312,500	257,688
San Bemis	95	1,575	11,310
San Antonio	2,000	75,000	50,000

It is the intention to provide in the cañons of the Verdugo watershed channels of approximately rectangular section. The sides, however, will be composed of cylinders of loose rock wrapped in heavy wire net, embedded a foot below the bottom of the channel and of sufficient diameter to give a waterway that will take care of a flow 30 to 50% in excess of the maximum observed. In the smaller streams a limiting velocity of 14 ft. per sec. was used. In the main intercepting channel this was reduced to 12½ ft. per sec.

Since the passage of the maximum possible water to the underground gravel is of great economic importance, it will be necessary to construct the improved channel so as to leave the bottom open to seepage. Flood velocities of close to 25 ft. per sec. may be expected, which would be likely to erode the bottom. It is therefore proposed to reduce the grade of the stream to 0.4% by means of weirs—similar to the Indian diversion weirs—built in the channel at intervals.

In addition to the retarding dams recommended by me for flood prevention, I also wish to emphasize the need of the construction of a considerable number of rock-fill dams 20 to 50 ft. high, by blasting down rocks from overhead cliffs, in this way creating permanent but porous cross-structures in the cañon. There will be no permanently retained water storage behind these dams. The retarding effect will be supplemented undoubtedly by forcing great quantities of water into all the fissures, crevices and porous material within the action of the head created by these barriers, so that they will materially help the underground supply.

Engineering Literature

Passing of a Notable Journal

The *Journal of the Association of Engineering Societies*, after 34 years of useful life, ceased publication with the December issue. In its early years this journal had a standing in engineering literature second only to the proceedings of the national societies. For a time more than a dozen city and state engineering societies scattered all over the continent from Boston to San Francisco coöperated in the publication of the *Journal*. The controlling reason for the final abandonment of the enterprise was the desire of most local societies at the present day to publish a journal of their own. Advertising furnishes the sinews of war for practically all publications, and the journal of a local society, notwithstanding its limited circulation, can obtain a local advertising patronage that a coöperative publication reaching a larger field is unable to secure.

The work done by the *Journal* for many years—making the important papers read before local engineering societies available to the profession—represents a valuable service, and those who have been responsible for its conduct deserve credit. At the time the *Journal* was established (1881) practically none of the societies that joined in its publication were financially able to undertake so large an enterprise as publishing a journal of their own. A dozen societies coöperating, however, were able to furnish material from the best of the papers read before them, which made a most creditable and useful publication.

Those who recall the first years of the *Journal* will agree that another reason for its early success and for the prestige then gained that helped to support it through succeeding years was the energy and ability expended upon it by the late Prof. J. B. Johnson, a man whose great services to the profession during his too short span of active life will long be remembered.

Expert Dealer in Second-Hand Engineering Books

A prominent engineer in the Middle West sends us a letter calling attention to the need of a central exchange for the purchase and sale of back volumes of *Engineering News* and other technical periodicals valuable for reference, and of engineering libraries.

Here are a need and an opportunity that some engineer ought to recognize. We say engineer, because the ordinary dealer in second-hand books has not enough knowledge of values to render sufficient service to make the business profitable. Very likely such a business might not yield a profit that would make it attractive to a young and ambitious man. It ought, however, to do considerably more than pay its expenses. Some engineer with a liking for books and who has passed the age when he enjoys the hard routine work of the profession might well earn a good living in such a business and render besides a distinct service to the profession.

There is now a very large number of public libraries which should contain a good assortment of engineering reference books, in addition to the reference libraries of engineers in private practice. There should be a steady demand for second-hand books and bound volumes of periodicals from all such libraries; and such a demand would doubtless be stimulated if a known source of supply were available. On the other hand, through deaths and business changes the libraries accumulated by engineers frequently become available for purchase.

One advantage of a business of this sort is that much of it could readily be handled on a commission basis, shipments of books being made direct from the seller to the purchaser, so that the amount of capital necessary to invest in it would be comparatively small.

CORRESPONDENCE

Need of Standard Terms in Sewage-Disposal Work

Sir—In the last ten years or so developments in the art of sewage treatment and disposal have been rapid, and it is not strange that during this development period different names or terms have been given to, or used in, describing some particular device or process of treatment. A few illustrations will serve to point out how desirable it would be if, for any given device or process, one standard name or term only could be used.

Thus, an Imhoff tank is also called an Emscher tank, a two-story settling tank, a two-story septic tank and an Imhoff septic tank. Grit chambers are sometimes called detritus tanks. And if we consider the latest development in the art of sewage treatment—that is, the treatment of sewage with activated sludge—we find this method spoken of also as forced aëration. The tank in which the treatment is carried out is often called an activated-sludge tank, an aëration or aërating tank and also an aëro tank.

Again, the names trickling filter, sprinkling filter and percolating filter are used synonymously in America, while in England this same type of filter is called a bacteria bed. The writer is perhaps partly responsible for the use of the term sprinkling filter, owing to the fact that it was decided to give this name to the filters in the sewage-treatment works which were built some ten years ago under his direction at Columbus, Ohio, these being the first large works designed in this country to use that type of filter. As the sewage was to be sprinkled, or sprayed, over the surface of the filter, it was then thought that the term sprinkling filter would be the best one to adopt. The writer is inclined to believe now, however, that the term trickling filter is a much better one, as it conveys an idea of how the filter operates, independently of how the sewage is applied to the surface of the filter.

That others evidently recognize the need of a set of standard names or terms for use in sewage disposal may be seen from the following paragraph taken from a standard treatise on that subject:

> The following definitions are introduced here to avoid confusion as to the meaning of certain terms. The word rack signifies screening apparatus consisting of parallel bars. The word grating means screening apparatus composed of two sets of parallel bars, the sets intersecting at right angles. The word screen indicates either wire cloth or a plate of metal perforated with holes of small size. By wire racks will be designated the few screens consisting of parallel wires stretched tightly between frames. If the racks are stationary they will be termed fixed, and if they are capable of motion they will be termed movable; the same classification will be applied to screens.

While engineers may not all agree as to whether the terms adopted in this treatise for different kinds of screening apparatus are the best that can be selected or whether new words need to be coined, nevertheless here is a definite attempt to use one name or term for some particular device; and this attempt is decidedly a step in the right direction.

In the treatise referred to, the materials removed by racks, gratings and screens are all classed as screenings. In the writer's opinion the term screenings is the best one to use to describe all such materials as are removed by screening apparatus, of whatever type. He is free to admit, however, that he has not yet become entirely accustomed to the terms rack and grating. There invariably comes to his mind the thought that if the materials removed by a screen are called screenings, would not the materials removed by a rack be called rackings? And following this line of thought still farther, if the term grate had been used instead of grating, would not the materials removed by a grate then naturally be called gratings?

The writer, in expressing the thoughts which involuntarily came to his mind when first reading about racks, gratings and screens, means no disrespect whatsoever to the treatise referred to, as he considers it one of the best, if not the best, which has been published on the subject of sewage treatment and disposal; and he realizes that the terms chosen must have been decided on only after the most careful thought. His only purpose in referring to the terms used in this treatise to describe different kinds of screening apparatus is to call to the attention of sanitary engineers the necessity of getting together on, and of adopting, a set of standard names or terms for use in sewage-disposal work and of then using these terms, even if some of them do not entirely meet an engineer's personal point of view.

The great desirability of having a set of standard names or terms was brought home to the writer more strongly than ever while reading the treatise referred to, and the plan followed in that treatise of using one name or term only for any one given device, so far as possible, is greatly to be commended.

It seems to the writer as if it would be highly desirable for some suitable engineering society to take steps to secure the adoption of a set of standard names and terms for use in sewage-disposal work. If there only was in this country a national society consisting of members interested especially in the subject of sewage treatment and disposal, similar to the Association of Sewage-Works Managers in England, then the work of getting up a standard could well be done by such a society. In the absence of such a society, however, the work might be undertaken by the Sanitary Engineering Section of the American Public Health Association or the Sanitary Section of the Boston Society of Civil Engineers or by joint action of the two.

That at least one society, and a national one at that, recognizes the necessity of having standard definitions of terms used in certain branches of work may be seen by referring to the 1915 Year Book of the American Society of Testing Materials, in which are given standard definitions of terms used in paint specifications, of terms applicable to materials relating to roads and pavements and of terms relating to structural timber and sewer pipe.

While the above discussion has been limited to a plea for a set of standard names or terms for use in sewage disposal, nevertheless the necessity exists for the use of standard terms also in both water-works and refuse-disposal engineering—in fact, in all branches of sanitary work—and if either or both of the previously mentioned societies, or any other society or association of engineers, or the technical press should make up and adopt a set of standard names or terms for use in the several branches of sanitary engineering, not only would the thanks of all sanitary engineers be earned, but also of engineers interested in other classes of work and of laymen who often have sanitary problems brought before them for consideration.

JOHN H. GREGORY.

170 Broadway, New York City, Jan. 29, 1916.

REVIEWS AND NOTES

Materials of Engineering

REVIEWED BY CLYDE T. MORRIS*

THE ELASTICITY AND RESISTANCE OF THE MATERIALS OF ENGINEERING—By William H. Burr, M. Am. Soc. C. E., Professor of Civil Engineering in Columbia University. New York: John Wiley & Sons. Seventh edition, thoroughly revised. Cloth; 6x9 in.; pp. xix + 928; illustrated. $5.50 net.

The seventh edition of this work has been largely rewritten and revised and presents the subject in a much clearer and more logical style than did the previous edition. The book contains about 140 fewer pages than the old edition, due to the omission of the tables from the Cambria Steel Co.'s handbook and copies of various standard specifications, which are easily obtained by the student and are much more convenient to use in separate form.

The book is divided into two parts—I, Analytical; II, Technical—the intention evidently being to cover the subject of the mechanics of materials in the first part and to give the practical applications, together with the results of tests, in the second part. This division makes it difficult in some cases to get a comprehensive grasp of a subject from the text, as part of it will be found in one chapter and part in another. The flexure of long columns is an instance. In Chapter II is given the elementary theory, and the practical formulas and methods of design are not given until Chapter X.

Part I has been partly rewritten and enlarged by about 80 pages. An extended discussion of the fundamental relations of stresses, including the ellipse and ellipsoid

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of stress, has been added to Chapter I, and old Chapter II has been expanded into two chapters by adding considerable matter to the treatment of hollow cylinders and spheres. The description of combined-stress conditions in Chapter IV is especially good.

In Part II, Chapters VII and VIII, "Tension" and "Compression," present the practical side of the matter in good shape. Chapter IX, "Riveted Joints and Pin Connections," gives very little attention to pin connections; and part of the discussion of riveted joints relating to the bending of the rivets in butt joints with two splice plates is obsolete, as it neglects entirely the friction between the plates, which experiments have shown to be the main resisting factor for loads up to the usual working stresses.

Chapter X, "Long Columns," gives a review of the usual column formulas and the more recent tests of columns. Chapters XI and XII, on shearing, torsion and bending, have not been greatly changed. The part relating to the stresses in short solid beams, such as bridge pins, is especially good.

Chapter XIII, "Concrete-Steel Members," has been greatly enlarged and the experimental data brought down to date. Articles on T-beams and reinforced-concrete columns have been added. In his preface the author states regarding this chapter: "The analysis given is general, but simple and free from the superfluous and labor-increasing accretions which for some not obvious reasons, have found place in some of the commonly used formulas."

After reading this, it was with genuine disappointment that the writer waded through the involved mathematical analysis of the stresses in reinforced-concrete beams given in this chapter. The analysis is given for the most general case of a double reinforced T-beam in which both the compression and the tension in the stem of the beam are taken into account, and then the usual working formulas are derived by making certain factors equal zero. The treatment of shearing stresses and web reinforcement is good, as is also the treatment of reinforced-concrete columns.

Chapter XIV, "Flanged Beams," is good. Chapter XV gives a complete design for a deck plate-girder railroad bridge, according to the American Railway Engineering Association specifications.

Chapter XVI "Miscellaneous Subjects," includes among others a good discussion of the stresses in hooks, helical and spiral springs, eccentric loading, oblique or general flexure, stresses in flat plates, and the method of least work applied to the stresses in a bridge portal. Chapters XVII and XVIII, on "Fatigue of Metals" and "Flow of Solids," are not changed from the old edition.

Three appendices are added, the material in which it would seem to the writer might just as well have been included in the proper place in the text. The title of Appendix I is identical with that of Chapter I of the book. Appendix II gives Clavarino's formula for the stresses in thick hollow cylinders, and Appendix III gives an account of some tests of the resisting capacity of natural and artificial ice.

The greatest objection to the book is its lack of system in notation. A symbol may be given a meaning in one article and have an entirely different meaning in a preceding article to which reference is made. For instance, in Art. 82 the deflection is denoted by Δ, and in Art. 27, to which reference is made for the formula, the deflection is denoted by w. Also in equation (20), Art. 91, d is the depth of the beam, while in equation (8), Art. 15, to which reference is made for the derivation of equation (20), d is the distance from the extreme fiber to the neutral axis. These variations in notation are very confusing, especially as the meanings of the symbols are dispersed throughout the text and are not always easily found.

It is surprising that the chapter on concrete-steel members has not been revised so that the notation will agree with that recommended by the Joint Committee on Concrete and Reinforced Concrete. The notation used is not uniform, even throughout the chapter, and its lack of conformation renders the chapter very difficult to read, especially to one accustomed to the ordinary usage.

The work should make a valuable reference book for the practicing engineer, as the interpretations of tests are generally sound and the suggestions as to details of design are good.

Building-Cost Figures

THE BUILDING ESTIMATOR'S REFERENCE BOOK: A Practical and Thoroughly Reliable Reference Book for Contractors and Estimators Engaged in Estimating the Cost of and Constructing All Classes of Modern Buildings, etc.—By Frank R. Walker. Chicago, Ill. (30 North Michigan Ave.): The Author. Flexible leather; 4x7 in.; pp. v + 612; illustrated. $10.

The most striking feature of this book is that it costs $10, although from its outward appearance and comparison with similar books it should not cost more than a quarter of that amount. Whether it is worth $10 or not must be a matter of opinion. It does contain a vast number of cost data, a great many of which do not, as is usual, vary tremendously with individual jobs. The figures are reduced to their lowest terms and stated in the briefest possible fashion for clearly differentiated cases, and it is no doubt a fact that many builders or contractors would find such a collection well worth the price charged for the book.

The one distinguishing characteristic of the volume is the broad field covered by the figures. They start with general contracting figures—such as overhead expenses, erecting and excavating, caissons, piles, concrete and reinforced concrete, brick masonry, stone masonry, fireproofing—and go through the minor details of building construction—such as carpentry, millwork, plastering, doors, windows, sheet-metal work, glass, glazing, painting, plumbing, electric wiring, etc.

If the user is of sufficient judgment to convert these figures to his local requirements and variations, he will undoubtedly find the book of great value.

A Story of Arctic Adventure

ANNUAL REPORT OF DEPARTMENT OF THE NAVAL SERVICE OF CANADA, 1914-15—Ottawa, Canada. Paper; 7x10 in.; pp. 138. 10c.

This report contains the diary of Captain Bartlett, who accompanied Peary on his expedition to the north pole and who was captain of the "Karluk," the ship used by the Stefansson Arctic exploring expedition that started in 1913 to explore the regions to the north of Bering Strait. The "Karluk" was crushed in the ice in the Arctic Ocean on Jan. 11, 1914. The narrative of Captain Bartlett's journey to the mainland and thence back to Bering Strait to obtain rescue for the other members

of the party, as related in his diary, is a most interesting one.

The report also contains accounts of the ice conditions in Hudson Bay and Strait in 1914, of especial interest in connection with the project for carrying on ocean traffic by the Hudson Bay Ry. route. The Canadian survey steamer "Acadia" made the voyage to Port Nelson, spending the months of August and September in Hudson Strait and Bay, but encountered so much ice that she was damaged to the extent of $25,000. The report relates in detail the heavy ice conditions, the serious obstructions from fog, etc., that vessels must encounter in navigating the strait and bay during the half-dozen weeks in August and September in which passage is usually possible.

Against Isolated Power Plants

POWER FOR PROFIT: Principles Governing the Use of Machinery and Labor in Modern Buildings—By Reginald Pelham Bolton, author of "Building for Profit," "Elevator Service," "An Expensive Experiment," etc. New York (55 Liberty St.): The R. P. Bolton Co. Cloth; 8x11 in.; pp. 209. $2.50 postpaid.

Any who desire an extreme statement of the case against private isolated utility-service plants need Mr. Bolton's book—although it is aimed at the real-estate operator particularly. Attempting to reach this class of expected readers probably explains the dilute matter, smooth style and *ex cathedra* presentation. While not the primary object of the book, yet no chance is lost to criticize municipal ownership. Bluntly and brutally summarized, the argument of the book runs thus:

The chances against economical isolated utility service are very great. The more machinery there is used in a given service the more necessity there is for multiplied output and the greater the need of labor. Improvements in machinery result only in higher-class labor and greater labor expense. The general extension of public-utility systems lessens the advantages of private plants and reacts on itself to reduce the cost of service. Reduction in public-utility rates reduces the value of isolated plants. New combinations of company-supplied machinery continually offer new economies that a private plant cannot give. Reductions in company rates continually reduce private-plant values, and new combinations of central-station service offer new economies that a private plant cannot produce. Privately owned machinery is very liable to bring destructive accidents. Danger of accident is large in all machine plants, and protection of private-plant employees lags behind that of men in commercial utility service. In private plants touted economies are grossly exaggerated. Burdens of deterioration and obsolescence are not easily borne by the private-plant owner and consume his capital. Real-estate owners should not dabble in a strange business.

Silo Construction in Concrete

CONCRETE SILOS: Their Advantages, Different Types and How to Build Them—By E. S. Hanson, Editor of "Cement Era." Chicago: Cement Era Publishing Co. Cloth; 5x8 in.; pp 174; illustrated. $1.

The silo has proved its value in agricultural practice. The numerous systems of its construction now advertised and promoted are sufficient evidence of that, were any structural evidence required. This book is devoted to a description of the methods of building concrete silos. Unfortunately, the author considers that special pleading for his type of structure is necessary and so devotes several chapters to showing how poor all other types are. This, of course, removes the book from the strictly technical field; but if these chapters were not included, thus eliminating the obvious prejudice, the chapters of description would be well worth while.

Elementary Thermodynamics

REVIEWED BY C. R. RICHARDS*

ENGINEERING THERMODYNAMICS—By James Ambrose Moyer, Professor, and James Park Calderwood, Associate Professor, of Mechanical Engineering, Pennsylvania State College. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. viii + 203; 71 illustrations. $2 net.

Thermodynamics has never been classed among the "snaps" in the college curriculum, and few students in courses outside of those in which the subject is required "elect" it to fill up their schedule of studies. Without doubt it is a "hard" subject, and the student who masters it must expect to do real work. However much teachers of the subject may try to smooth out the difficulties, it is doubtful whether it can ever be presented in words of one syllable.

In their preface to this latest addition to the rapidly growing list of books on thermodynamics, Professors Moyer and Calderwood assert that "for years there has been an important demand for a textbook on thermodynamics which would be brief and concise, but at the same time so clearly written as regards explanation that students of average ability in our large technical schools could read it without difficulty." It may be assumed that the authors present the volume under review as one which in their opinion fully meets this demand. An inspection of the book indicates, however, that the difficulties have been overcome in part by the omission of some of the more difficult subjects normally considered desirable or essential components of a well-rounded course in thermodynamics and by the avoidance of the highly mathematical and generally more convincing treatment found in more pretentious treatises on the subject. In general, the matter presented and the treatment employed in the book are similar to those given in a number of books on the steam engine.

The authors have not been entirely successful in the elimination of statements which are likely to be misleading to the average student. Instances are the use of the term "practically perfect vacuum" where perfect vacuum is meant; the use of "mass" instead of weight; the failure to distinguish between adiabatic changes which are isocentropic and those which are not; the statement that "it is not at all unusual to have steam leaving boilers which is not perfectly and completely vaporized"; and in the verbal, and consequently useless, discussion of Hirn's analysis the assertion that "it is possible to determine exactly the heat added to or lost from the steam." Again the impression is given that the entropy-temperature analysis of an actual steam-engine diagram or cycle gives a correct interpretation of the distribution of heat losses for the whole cycle, when as a matter of fact it can only show correctly what occurs in the cylinder during the period between cutoff and release, in which there is a constant weight of steam in the cylinder.

The volume is divided into nine chapters as follows: "Introduction to the Theory of Heat Engines"; "Prop-

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erties of Perfect Gases"; "Expansion and Compression of Gases"; "Cycles of Heat Engines"; "Properties of Steam"; "Practical Applications of Thermodynamics"; "Entropy"; "Practical Steam Expansions and Cycles"; "Flow of Fluids." Of these the most nearly satisfying is the one devoted to the flow of fluids. Some of the chapters contain matter of trivial importance, and in all of them the treatment of the subject is elementary.

Steam Power and Steam Tables

REVIEWED BY CARL C. THOMAS*

STEAM POWER—By W. E. Dalby, M. Inst. C. E., London University, Professor of Engineering at the City and Guilds Engineering College of the Imperial College of Science and Technology. New York: Longmans, Green & Co. Cloth; 6x10 in.; pp. xvi + 760; 250 diagrams. $6 net.

THE CALLENDAR STEAM TABLES—By H. L. Callendar, Professor of Physics in the Imperial College of Science and Technology, South Kensington; author of "The Properties of Steam." New York: Longmans, Green & Co. Cloth; 6x9 in.; pp. 40. Steam diagram in pocket. 80c.

The two books here considered have one thing in common—a very satisfactory set of steam tables, in both cases prefaced by Professor Callendar. The larger book will first be considered.

Those acquainted with the earlier works by Professor Dalby, including his book on the "Balancing of Engines" and various notable reports of experimental investigations, will not be disappointed in his new book. It will be welcomed by the engineering profession in general as a notable contribution to the literature of its subject. It is written with characteristic clearness and simplicity, and it covers the subject of "Steam Power" in a way that is especially suitable for rather mature students of engineering. This does not mean that the elementary treatment of thermodynamics has been neglected, but rather that the book goes somewhat farther into the various phases of the subject than students approaching engineering thermodynamics for the first time are likely to go in an elementary course. This is nothing against the book, excepting in so far as the cost of 760 pages is rather high for an elementary text.

The book is well arranged from a pedagogical standpoint. It begins with a well-illustrated chapter of some 53 pages, "General Action of a Steam Plant." This is followed by a chapter, "Steam Boilers," containing illustrations and examples of typical calculations. In this chapter the subject of combustion is well treated. An excellent discussion is given of heat transference and also of the operation of smoke-stacks. Chapter 3 is called "The Motive Power Circuit" and deals with the thermodynamics of the steam plant, introducing also typical calculations illustrating elementary theory. Chapter 4 continues the subject of Chapter 3 into the field of performance of steam engines and contains valuable data upon modern practice and methods of analyzing performance. One of the subjects most satisfactorily treated is the derivation of the general expression for the adiabatic curve, $P\,V^{\gamma} = C$. Teachers of elementary thermodynamics are quite likely to content themselves by stating to the student that while isothermal expansion of a perfect gas is represented by the equation $P\,V = C$, other forms of the expansion curve may be represented by a more general equation $P\,V^{\gamma} = C$. This is very unsatisfactory to the really interested student, and Professor Dalby has derived the equation for adiabatic expansion (pages 144 to 152) in a beautifully clear manner, upon the basis of the fundamental equation $E + W = Q$ in which W represents external work done by the expenditure of energy E. The book as a whole should be commended for many other examples of such fundamental treatment.

There seems to be some little confusion of symbols in the section of the book referred to, due perhaps to the use of K with subscripts to represent specific heat, instead of using it to represent equivalent foot-pounds. A reader familiar with the subject can easily make such slight corrections are are necessary. On page 208 the expression for entropy, at the top of the page, is not quite clear—"in general for any path entropy equals $\frac{Q}{T}$." It is probable that this is intended to refer only to the isothermal path.

A new heat unit has been adopted in this book, the "pound-calorie," or the amount of heat required to raise the temperature of 1 lb. of water 1° C. The wisdom of this addition of another heat unit is open to question. Our units are now so diverse that it would seem we should either adopt the metric units as a whole or else adhere to the British system. The steam tables included with Professor Dalby's book give heat and work quantities in pound-calories per pound and give parallel columns stating temperature on the Centigrade scale, starting from 0 absolute and from 0 C. respectively. These tables are the same as those published separately by Professor Callendar, and reviewed below.

Pressures are stated in pounds per square inch absolute. These tables are, as stated in the book, by Prof. H. L. Callendar, F. R. S.; and while the unit already referred to may be criticized, the derivation of the tables from Professor Callendar's characteristic equations are beautifully developed. This treatment is perhaps the most satisfactory at present available for anyone wishing to understand the source of the present steam tables. The quantities given in the tables correspond with the best data now available.

Following a chapter on "The Performance of Steam Engines" and one on "The Cooling Circuit," dealing with the subject of condensers and auxiliaries, Professor Dalby has given a chapter on his "Characteristic Energy Diagrams." In this chapter results of several tests of steam locomotives have been plotted on coördinates of indicated horsepower and pound-calories transferred across heating surface per minute. This system of analysis was described by Professor Dalby, in *Engineering* some years ago and is to be commended to students and engineers.

Chapter 7 deals with the "Dynamics of Steam Engines," including the subject of methods of governing and leading up to an excellent chapter on the balancing of engines and the motion of a train. In the work on locomotives the investigations of Prof. W. F. M. Goss are discussed quite fully, and many of his extensive tests, as well as tests made by the Pennsylvania Railroad Co., are analyzed in a very satisfactory manner.

Chapter 10 deals with "Valves and Valve-Gear Mechanism." It is well illustrated and altogether an excellent treatment of the subject, taken largely from Professor Dalby's book on "Valve Gears."

Chapters 11 and 12 deal with the flow of steam and with steam turbines. These chapters are somewhat too brief, but present the subject in excellent manner, showing

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methods of calculation from experimentally determined results. Professor Dalby uses the terms "impulse-pair" and "reaction-pair" in connection with turbines. This is an improvement over the word "stage," which has been a source of confusion heretofore. The stationary bucket is just as important in the Parsons turbine as is the nozzle in the impulse turbine, and it is therefore not logical to speak of one row of Parsons buckets as a stage.

The book contains a few statements which are perhaps not entirely satisfactory, but those portions will be of particular interest only to mature engineers who are able to discriminate; and such debatable points as do arise are largely matters of definition and not of scientific understanding. On page 311, in connection with condensers, it is interesting to note the confusing expression "saturates a given volume." This expression is used to indicate that the water vapor occupying the space or volume is in a saturated condition.

The book concludes with the steam tables previously referred to and a large number of examples, the answers to which are given by the author.

Professor Callendar's small book affords a very clear and well-presented set of data on the properties of steam—saturated and superheated. Parallel columns give temperatures in Centigrade and Fahrenheit units. Volumes are stated in cubic feet and cubic meters, and heat quantities are given in both Centigrade and Fahrenheit units, all in parallel columns. The heat quantities are given on the foot-pound-Centigrade system, to the use of which the criticisms made in the review of Professor Dalby's book apply. The values in the tables are tabulated on the following three systems—foot-pound-Centigrade, foot-pound-Fahrenheit and kilogram-meter-Centigrade. The tables are preceded by about 20 pages of beautifully written explanatory text.

Water-Works of England

RETURN AS TO WATER UNDERTAKINGS IN ENGLAND AND WALES—By the Local Government Board, H. C. Monro, Secretary. London: T. Fisher Unwin. Paper; 8x13 in.; pp. xliii + 599. 5s. 1d.

All piped water-supplies reaching ten houses or more were included in an inquiry ordered by Parliament in 1910. After the individual returns had been gathered and put in type, proof was sent to the various reporters and the returns corrected, for the most part, to January, 1914. The compilation was ordered printed on July 28, 1914, but apparently the European War delayed publication until 1915.

The body of the report consists first of a summarized description of each "water undertaking" in England and Wales and next of the supply to each "district," including rural parishes.

The undertakings or water-works described include those of 786 separate local authorities, the Metropolitan Water Board and 34 other joint authorities, 284 companies and 1,055 private proprietors—the latter being very small supplies, as a rule. The descriptions comprise the places supplied by each works, date of grant of parliamentary powers, source, quantity and character and general efficiency of supply, rate of filtration if any, storage capacity and average daily consumption. The hardness of the water and whether it acts on lead are given.

The particulars reported for each district having a water-supply are area, population, number of houses, both total and supplied, and the name of the owner of the works. The same table states for each parish in a rural district without a piped supply whether water is drawn from wells, springs or otherwise, together with the nature and efficiency of the supply.

Altogether a piped service is supplied to 1,101 of the 1,130 boroughs and urban districts and to 4,874 of the 12,869 parishes in rural districts.

The return is prefaced by a summary and a few recommendations for legislation, the latter including suggestions for the establishment of river boards to control water pollution and to supervise the distribution of both river and underground waters.

British Building Data

RIVINGTON'S NOTES ON BUILDING CONSTRUCTION. A Book of Reference for Architects and Builders and a Textbook for Students (in two volumes)—Edited by W. Noble Twelvetrees. New edition, entirely rewritten. New York: Longmans, Green & Co. Cloth; 6x9 in. Part I, pp. 306; 484 illustrations. Part II, pp. 332; 395 illustrations. $2.25 each.

The main value to American readers of British books on such a subject as building construction is not so much to help them in the details of design as to indicate to them how other engineers under different conditions are solving the same problems. It is of course not necessary to emphasize the great difference between European and American practice in building. This does not mean, however, that the American cannot learn much from the older practitioner, and in acquiring this learning there is probably no better book on the particular subject than the one now under consideration. The book was first published about 40 years ago, and it had so wide a circulation in England that the publishers decided a few years ago to bring it down to date under the direction of the well-known concrete engineer, W. Noble Twelvetrees.

The revised edition, which is quite modern, includes such subjects as building regulations, timbering, excavations, scaffolding, brickwork, masonry, arches, chimneys, steel skeletons, reinforced concrete, carpentry, roofs and roofing, timber roofs, steel roofs, joinery, plastering, water-supply, gas, lighting, power equipment, etc. There is no doubt that builders could find in such a book many items that would help them in their practice.

British Refuse Destructors

REFUSE DISPOSAL: A Practical Manual for Municipal Engineers, Members of Local Authorities, Etc.—By Ernest R. Matthews, Assoc. M. Inst. C. E., Chadwick Professor of Municipal Engineering. London: Charles Griffin & Co. Philadelphia: J. B. Lippincott Co. Cloth; 5x8 in.; pp. 160; 99 illustrations. $2 net.

A brief description of British practice in refuse burning is here presented, together with some remarks on refuse collection, on "unsatisfactory methods of disposal" by dumping on land and at sea and by "purchase by farmers," and on "crushing and converting into manure." A half dozen British types of destructors are described. There are a chapter on small installations for villages and institutions, another one on the use of clinker, two chapters on chimney construction and finally a chapter on vacuum cleaning for buildings. The book contains much less information than those by Goodrich on the same general subject, but is less expensive and considerably more recent.

Electrical Testing Explained

ELECTRICAL MEASUREMENTS AND METER TESTING: A Book in Plain English for the Student and Practical Man; Fundamental Theory, Practical Applications and Examples—By David Penn Moreton, Associate Professor of Electrical Engineering, Armour Institute of Technology, Chicago, Ill.; Frederick J. Drake & Co. Linen; 4x7 in.; pp. 328; 191 illustrations. $1.

Professor Moreton has produced an excellent little book on electrical testing, useful for nonelectrical engineers. A large amount of space is devoted to the elementary theory of electric circuits and the construction of commercial instruments. The measurements covered include resistance, inductance, capacity, current, potential, power and energy. Calibration of galvanometers, ammeters, voltmeters, wattmeters and watt-hour meters, demand indictors, etc., is described.

Automobile Engineering

THE GASOLINE AUTOMOBILE—Prepared in the Extension Division of the University of Wisconsin by George W. Hobbs, Instructor in Mechanical Engineering in the University Extension Division, and Ben G. Elliott, Associate Professor of Mechanical Engineering, University of Nebraska. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 259; 253 illustrations. $2 net.

This book, according to its preface, is the outgrowth of extension work carried on by the University of Wisconsin. The text has been developed from a series of lectures given by the authors in 23 cities last winter. As might be expected, therefore, the book is designed for the average intelligent man. That the book is up to date is illustrated by the fact that 31 pages are devoted to starting and lighting systems. The treatment of carbureting systems is almost equally full.

In the compilation of any such book as this the problem is to know what to include and what to leave out. Nothing like exhaustive treatment of the subject in a single volume is of course possible, for automobile engineering has already become an art represented by a large national engineering society and a voluminous literature. On the whole the authors seem to have used discriminating judgment in the preparation of their book.

Report on Chicago Railway Electrification

SMOKE ABATEMENT AND ELECTRIFICATION OF RAILWAY TERMINALS IN CHICAGO. Report of the Chicago Association of Commerce Committee of Investigation on Smoke Abatement and Electrification of Railway Terminals. W. F. M. Goss, Chief Engineer. Chicago: Rand-McNally & Co. Cloth; 9x12 in.; pages 1,177; illustrated. $6.

By far the most extensive and thorough study ever undertaken of the pollution of city air by smoke and other causes and of what would be involved in transformation from steam to electric traction of all the railway lines within a great city is the investigation which has been carried on at Chicago for the last four years, the results of which are summarized in this book.

The investigation was made under direction of a commission, of which four members were appointed by the mayor of the city, four by the railway companies and nine by the Chicago Association of Commerce. The funds necessary to carry on the investigation were provided by the railway companies, and it is stated that something like a quarter of a million dollars has been spent. A staff of expert engineers was organized by the commission and has carried on the work with scientific thoroughness. The impartial character of the report is guaranteed not only by the character of the citizens who made up the commission, but by the high standing of the engineers who were in charge of technical matters.

In every city where problems of smoke abatement may hereafter be studied and in the office of every engineer who has to deal with problems of railway electrification, this report will be invaluable for reference. A brief summary of the conclusions was printed in *Engineering News* of Dec. 9, p. 1141.

It may be stated here that the commission's investigations showed that the smoke from steam locomotives is responsible for only one-fifth of the smoke present in the air of Chicago, and further that if electrification of the entire railway system of the city were undertaken the railways would have to invest about $250,000,000 to carry out the work.

The report contains a vast mass of statistics, tables, diagrams, etc., which is, however, only a small part of the data accumulated by the commission. The additional data will doubtless be preserved and made available for reference by engineers and others in some public library. The questions which have been so exhaustively studied at Chicago are certain to come up for discussion and investigation in other cities, and it is fortunate that authoritative data, collected and arranged by impartial observers, will hereafter be available.

German Official Socialism

SOCIALIZED GERMANY—By Frederic C. Howe, author of "The City: the Hope of Democracy"; "The British City: the Beginnings of Democracy," etc. New York: Charles Scribner's Sons. Cloth; 5x8 in.; pp. x + 342. $1.50 net.

Much interesting information on municipal, state and imperial ownership of utilities and on many phases of social welfare work in Germany is given in this book. The substance of some of the information was previously available in more or less scattered form, but the author has brought it together, vivified and illumined it from what he terms a "rather intimate knowledge of German life during the past quarter century."

The author's conception of what Germany does for its people is thus expressed in his preface:

> Germany is more intelligently organized than is the rest of the world. The individual German receives more from society. He is better protected in his daily life. The gains of civilization are more widely distributed than they are with us. His dignity and his personal liberty are on a different, and from our point of view on a lower, plane than in America and Great Britain, but his daily and hourly needs, and those of his wife and family, are better cared for. And the individual man is more efficient. He is better prepared for his life work. He enjoys a wholesome leisure life. He is assured protection from "la misère" in old age. The workhouse does not await him if he falls by the wayside.

Besides the more general discussion, the book treats of state-owned railways, canals, waterways, harbors and river shipping, mines, forests and agricultural lands and the wide extent of municipal ownership. The various forms of German state insurance are described, and the educational system is outlined. Health-protective work, city planning, municipal land owning and housing, and city government by experts—all receive attention.

The book is all the more interesting and suggestive because the author, who is an ardent believer in social democracy, finds so much to commend in monarchical socialism.

A very interesting and valuable reference book is the general catalog of the United States Cast-Iron Pipe and Foundry Co. (Burlington, N. J.). It contains much readable matter on ancient water-works, a history of pipe founding and much detailed information about modern

water-works practice. The text also covers in detail other uses of cast-iron pipe, such as for culverts, sewers, gas and steam mains, etc. There are many useful tables; for example, tables giving the amount of lead in bell-and-spigot joints, standard thicknesses of water mains, standard dimensions of pipes and specials, etc., which relate specifically to the company's own products, while several pages are devoted to tables of general use—for the flow of water in iron pipe, friction heads for elbows, commercial pipe sizes for fire streams, contents of tanks and cisterns per foot of depth, etc. The whole forms a book of 222 pages 8½x10¾ in. in size, bound in black cloth. Needless to say, it is a book which every water-works engineer would like to have in his library.

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Anyone who desires a brief review of present and possible water powers of Canada should secure one or more of the official pamphlets recently issued by the Water Power Branch, Department of the Interior of Canada, for use with the Branch's exhibit at the Panama-Pacific Exposition.

The titles of these pamphlets are as follows: "Water Powers of British Columbia," "Water Powers of the Prairie Provinces," "Water Powers of Ontario," "Water Powers of Quebec" and "Water Powers of the Maritime Provinces." They are arranged particularly for popular reading and do not go into engineering details very extensively but furnish a good basis of departure for further investigations.

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Owing to a typographical error the number of pages in Ernest McCullough's "Practical Surveying," noticed on p. 1176 of *Engineering News* of Dec 16, 1915, was stated as 42 instead of 402.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION: Proceedings of Annual Convention Held at Atlantic City, N. J., June 9-11, 1915—Vol. 48. Chicago (1112 Karpen Building): Joseph W. Taylor, Secretary. Cloth; 6x9 in.; pp. 736; illustrated.

ANALYTICAL MECHANICS, for Students of Physics and Engineering—By H. M. Dadourian, Instructor of Physics in the Sheffield Scientific School of Yale University. Second edition, revised and enlarged. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xiv + 431; 148 illustrations. $3 net.

ANNUAL REPORT OF DIRECTOR OF RAILWAYS OF CHOSEN, 1913-14—Ryuzan, Chosen: Railway Bureau of Government-General of Chosen. Paper; 7x10 in.; pp. 85.

ANNUAL REPORT OF THE BOSTON TRANSIT COMMISSION—Boston (15 Beacon St.): B. Leighton Beal, Secretary. Cloth; 6x9 in.; pp. 102; illustrated.

ANNUAL REPORT OF THE DIRECTOR OF THE UNITED STATES GEOLOGICAL SURVEY FOR 1915—Washington, D. C. Paper; 6x9 in.; pp. 186; illustrated.

ANNUAL REPORT OF THE LIBRARIAN OF CONGRESS and the Report of the Superintendent of the Library Building and Grounds for 1915—Washington, D. C.: Superintendent of Documents. Cloth; 6x9 in.; pp. 221. 40c.

ANNUAL REPORT OF THE PHILIPPINE COMMISSION, 1914—Washington, D. C.: War Department. Cloth; 6x9 in.; pp. 426.

DAMS AND WEIRS: An Analytical and Practical Treatise on Gravity Dams and Weirs; Arch and Buttress Dams; Submerged Weirs, and Barrages—By W. G. Bligh, M. Inst. C. E., Inspecting Engineer of Irrigation Works, Department of Interior, Canada. Chicago: American Technical Society. Cloth; 6x9 in.; pp. 206; 122 illustrations. $1.50.

EARTH RESISTANCE AND ITS RELATION TO ELECTROLYSIS OF UNDERGROUND STRUCTURES—By Burton McCollum, Electrical Engineer, and K. H. Logan, Assistant Physicist. Washington, D. C.: United States Bureau of Standards. Technologic Paper 26. Paper; 7x10 in.; pp. 48; illustrated.

ELECTRIC RAILWAY ENGINEERING—By C. Francis Harding, Fel. Am. Inst. E. E., Professor of Electrical Engineering, Director of Electrical Laboratories, and Dressel D. Ewing, M. Am. Inst. E. E., Assistant Professor of Electrical Engineering, Purdue University. Second edition fully revised, enlarged and reset. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 416; 190 illustrations $3 net.

EXAMPLES IN MAGNETISM, for Students of Physics and Engineering—By F. E. Austin, Author of "Examples in Alternating Currents," "How to Design, Make and Operate High-Pressure Transformers," etc. Hanover, N. H.: The Author, Box 441. Second edition. Flexible leather; 5x8 in.; pp. 90; 27 illustrations. $1.10 postpaid.

EXPERIMENTAL WIRELESS STATIONS: Their Theory, Design, Construction and Operation—By Philip E. Edelman, author of "Inventions and Patents," "Simple Experiments in Chemistry," etc. Third revised edition. Minneapolis, Minn. (1802 Hague Ave.): The Author. Cloth; 5x8 in.; pp. 272; 98 illustrations. $1.50.

GEOLOGY AND UNDERGROUND WATERS OF THE NORTHERN LLANO ESTACADO—By Charles Laurence Baker. Austin, Tex.: Editor of University Publications, University of Texas. Bulletin 57. Paper; 6x9 in.; pp. 225; illustrated.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION: Proceedings of Annual Convention at Indianapolis, Feb. 23 and 24, 1915. Indianapolis (State House): Dr. W. F. King, Secretary. Paper; 6x9 in.; pp. 150.

INDUSTRIAL USES OF FUEL OIL—By F. B. Dunn. San Francisco, Calif.: Technical Publishing Co. Cloth; 5x8 in.; pp. 235; 108 illustrations. $3.

IRRIGATION PRACTICE AND ENGINEERING: Vol. III, Irrigation Structures and Distribution System—By B. A. Etcheverry, Head of the Department of Irrigation, University of California. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xv + 438; 186 illustrations. $4 net.

LIVE-LOAD STRESSES IN RAILWAY BRIDGES, with Formulas and Tables—By George E. Beggs, Assoc. M. Am. Soc. C. E., Assistant Professor of Civil Engineering in Princeton University. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. v + 123; 16 illustrations; 21 tables. $2 net.

MASTER CAR BUILDERS' ASSOCIATION: Proceedings of Annual Convention Held at Atlantic City, N. J., June 14-16, 1915—Vol. 49, Parts I and II. Chicago (1112 Karpen Building): Joseph W. Taylor, Secretary. Cloth; 6x9 in.; pp. 1972; illustrated.

THE METALLOGRAPHY AND HEAT TREATMENT OF IRON AND STEEL—By Albert Sauveur, Professor of Metallurgy and Metallography in Harvard University and the Massachusetts Institute of Technology. Second edition. Cambridge, Mass.: Sauveur & Boylston. Cloth; 8x11 in.; pp. xvi + 486; 438 illustrations.

PETROLEUM AND NATURAL-GAS RESOURCES OF CANADA: Vol. II, Description of Occurrences—By Frederick G. Clapp and Others. Ottawa: Mines Branch, Canada Department of Mines. Paper; 7x10 in.; pp. 404; illustrated.

POLE AND TOWER LINES, for Electric Power Transmission—By R. D. Coombs, M. Am. Soc. C. E. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. viii + 272; 162 illustrations. $2.50 net.

PROCEEDINGS OF THE CONFERENCE ON VALUATION, Held at Philadelphia, Nov. 10-13, 1915. [Published in "The Utilities Magazine," January, 1916.] Philadelphia (1009 Finance Building): Utilities Bureau. Paper; 9x12 in.; pp. 227. $2.

Among the topics covered are the reproduction and original cost theories of valuation; franchise, land and going value; depreciation, unit prices and priced inventories.

PUBLICATIONS OF UNITED STATES BUREAU OF MINES—Washington, D. C. Paper; 6x9 in.; illustrated.

Sampling and Analyzing Flue Gases—By Henry Kreisinger and F. K. Ovitz. Bulletin 97. Pp. 70.

Shot Firing in Coal Mines by Electricity Controlled from Outside—By H. H. Clark, N. V. Breth and C. M. Means. Technical Paper 108. Pp. 36.

PUBLICATIONS OF UNITED STATES GEOLOGICAL SURVEY—Washington, D. C. Paper; 6x9 in.; illustrated.

Water-Supply Papers—No. 351, Surface Water-Supply of the United States, 1913; Part I, North Atlantic Coast Basins—By Nathan C. Grover, Chief Hydraulic Engineer; C. C. Covert and G. C. Stevens, District Engineers. Pp. 189. No. 373, Water Resources of Hawaii, 1913—By G. K. Larrison. Pp. 190. No. 400-A, The People's Interest in Water-Power Resources—By George Otis Smith. Pp. 8.

Mineral Resources of the United States—No. 16, The Production of Iron Ore, Pig Iron and Steel in 1914—By Ernest F. Burchard. Pp. 477-539. No. 17, Copper in 1914—By B. S. Butler. Pp. 541-596. No. 31, The Production of Coal in 1914—By C. C. Lesher. Pp. 587-746. No. 32, The Production of Natural Gas in 1914—By John D. Northrop. Pp. 747-818. No. 33, The Stone Industry in 1914—By G. F. Loughlin. Up. 819-891. No. 34, Petroleum in 1914—By John D. Northrop. Pp. 893-1098.

SURFACE OILING OF EARTH ROADS—Prepared by B. H. Piepmeier, Maintenance Engineer. Springfield, Ill.: State Highway Department. Bulletin 11. Paper; 6x9 in.; pp. 28; illustrated.

VORLESUNGEN UEBER THEORIE DES EISENBETONS, Im Anhang Hilfstabellen, die deutschen Bestimmungen von 1915 mit Auslegungen, die oesterreichischen und die schweizerischen Vorschriften—Von Karl Hager, o. Professor an der Technischen Hochschule, Muenchen. Munich and Berlin: R. Oldenbourg. Cloth; 8x11 in.; pp. viii + 382; 330 illustrations.

Field and Office

Special Plant for Handling Spoil from Shafts

A special arrangement for removing spoil from subway shafts and for conveying it to the dock is being employed successfully by Holbrook, Cabot & Rollins on their section of the Broadway subway in New York City. The views show the plant at 39th St., and there is a similar arrangement at 41st St. just west of Broadway. The most important departure lies in equipping the large skips, or dump buckets, with wheels so that they can be easily moved about.

During the absence of the motor truck that conveys the skips the electric crane stationed on the overhead bridge, shown, raises loaded skips and stores them on the upper platform. When the truck returns and discharges its six empties onto the lower platform, by means of a movable bridge connecting platform and truck, the inner end of this bridge is raised to the upper level. The loaded skips are then rolled down the bridge and onto the truck. The skips are not always loaded onto the truck from the upper level, but are frequently handled directly from the shaft onto the truck, by means of the electric crane.

FIG. 1. ELEVATED CRANE HOISTING A WHEELED SKIP FROM A SUBWAY-EXCAVATION SHAFT

Eight Tests on Built-Up Timber Columns

By H. D. Dewell*

Built-up timber columns are very extensively used by carpenters, sometimes from necessity because of inability to secure the solid sticks, but more frequently on account of the ease of handling the smaller pieces comprising the columns. A third reason is the belief somewhat prevalent in the minds of the more ignorant that the built-up stick is stronger than the solid stick.

There are, however, occasions when it is necessary to use laminated columns, as in the curved compression chords of certain forms of arched trusses. It then becomes of moment to know what is the strength of such built-up columns, in order that they may be used intelligently.

It is believed justifiable to state that in all probability no built-up column as constructed in actual work is as strong as a solid one of equal dimensions. This is due to the fact that sufficient nailing is practicall impossible

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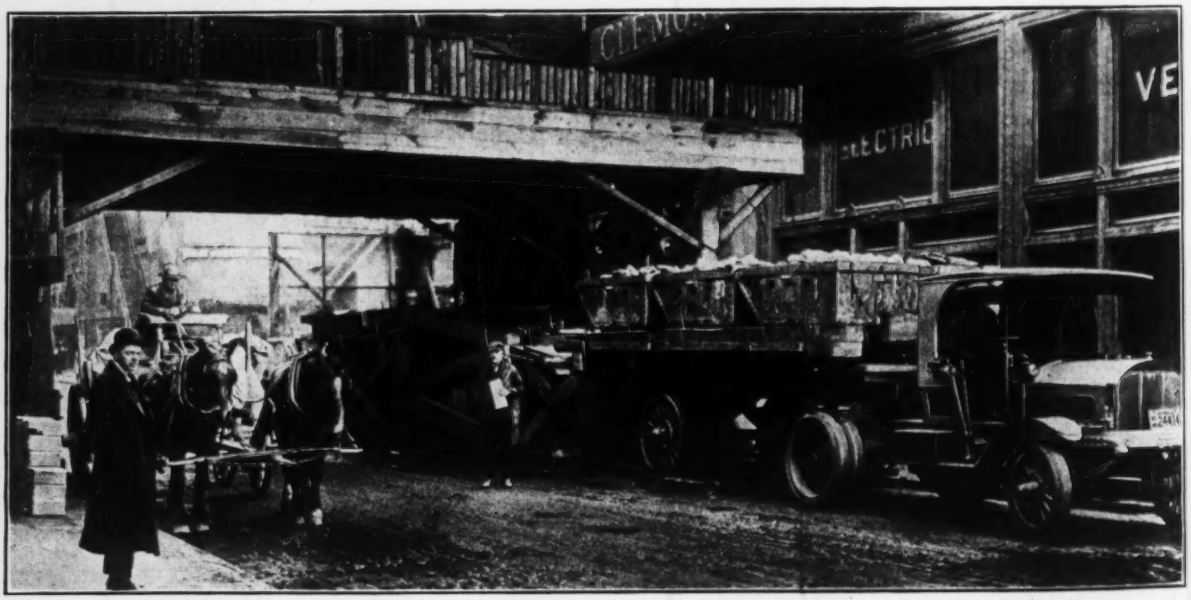

FIG. 2. TRUCK WITH SPECIAL BODY JUST LOADED BY THE CRANE AND PLATFORM ARRANGEMENT OF HOLBROOK, CABOT & ROLLINS ON NEW YORK SUBWAY CONTRACT

to section. In addition such composite columns usually contain joints between their ends, in which imperfect butts occur.

Professor Burr in his "Elasticity and Resistance of the Materials of Engineering" says, in speaking of the Watertown tests on compound columns:

> A number of tests, however, were made on compound columns formed by bolting together from two to three rectangular sticks with bolts and packing or separating blocks at the two ends and center. The bolts were parallel to the smaller sectional dimensions of the component sticks. As was to be expected, those compound columns possessed essentially the same ultimate resistance per square inch as each component stick considered as a column by itself . . . . a comparison of these results shows that these composite or built-up columns were the same in strength per square inch with the single sticks of which they were composed, the laths being considered single columns.

Composite columns built up of 2-in. material and thoroughly spiked together may undoubtedly be taken as giving a much stronger section than the sticks bolted at ends and center, as described in the preceding paragraph. What reduction in strength should be allowed for in a built-up spiked column is a question not at all definite and depends to a large extent on the arrangement

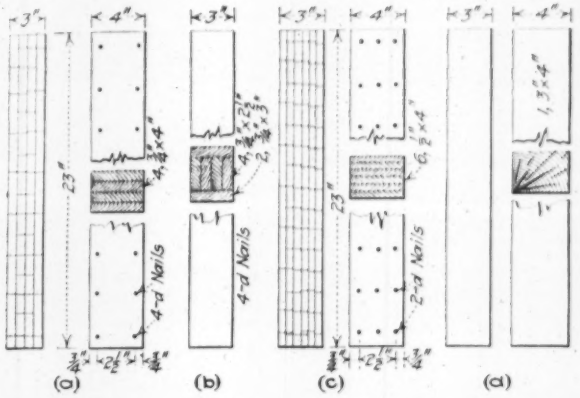

FIG. 1. DETAILS OF TEST COLUMNS

of the individual sticks and the extent and thoroughness of the spiking. A column built as in *b*, Fig. 1, is obviously much stronger than the same section when arranged as in *a*, Fig. 1.

Tests Made at Panama-Pacific Exposition

To throw some light on the subject the writer recently tested a few small columns built up as shown in Figs. 1 and 2. For comparison two columns of the same cross-section, but of solid timbers, were also tested (*d* in Fig. 1).

These tests were made on a 150,000-lb. capacity Olsen compression machine in the exhibit of the Tinius Olsen Testing Machine Co. at the Palace of Machinery, Panama-Pacific International Exposition, through the courtesy and interest of Mr. Olsen. The machine has an attachment for making autographic records of the deformation of the test pieces, the curves of which are reproduced in Fig. 3.

Eight small columns in all were made, two of solid timber, and the others built up. They were 3x4 in. in section, of surfaced No. 1 common Douglas fir, with ends true and square and surfaced. Unfortunately one of the two columns *b* disappeared, and only one specimen of this

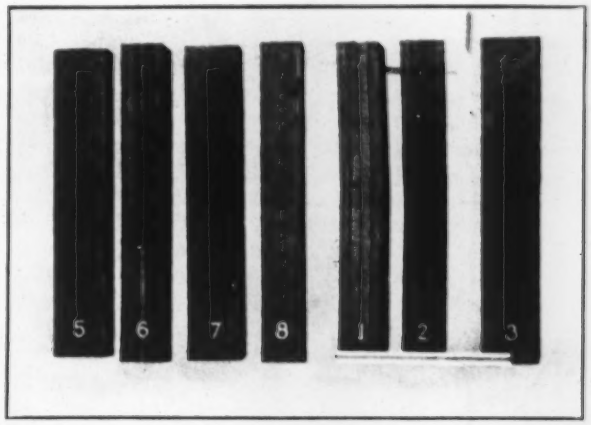

FIG. 2. VIEWS OF THE COLUMNS AFTER TESTING

type was tested. The specimens after test looked as shown by the view, Fig. 2.

The one column of Type *b* was found to be as strong as the solid stick. At the ultimate load, however, the individual pieces separated somewhat. The failure in this column was a combination of crushing, owing to straight compression, and of transverse, due to bending of the individual sticks.

While the two sticks *a*, built up of four 4x$^3/_4$ pieces, had a strength almost as great as the solid sticks, the failure was by bending of the column in the direction of the thickness of the individual boards. This failure was quite sudden.

The two columns of Type *c*, composed of six 4x$^1/_2$-in. boards, failed by bending very suddenly and without warning, the individual sticks bending in the direction of their thickness and the whole column bowing out some 3 or 4 in.

Spiking and Coverplating Important

While these tests are not sufficient in number and are too small in size to formulate working values for composite columns, they indicate to what a great extent the nailing is effective, and that wherever possible the sections should be constructed with "cover plates," well spiked into the edges of the inner boards or planks, similar to *b*, Fig. 1.

The writer has taken occasion at all times when the opportunity offered to examine the spiking or bolting of laminated columns in actual construction and has almost in every case found it to be far from sufficient to develop the full strength of the section.

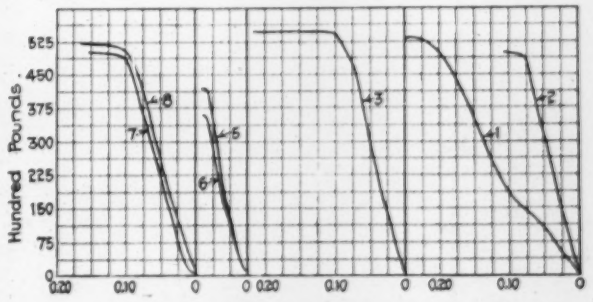

FIG. 3. LOAD-DEFORMATION CURVES FOR COMPOSITE TIMBER COLUMNS

Abscissas are deformations in inches